DEFINE

Development of an Evaluation Framework for the Introduction of Electromobility

Electromobility+

Project:

Development of an Evaluation Framework for the Introduction of Electromobility

ERA-NET TRANSPORT Transnational Call Electromobility+

Deliverable 8.1: Report on determinants and barriers of purchase of low carbon vehicles, including WTP estimates for specific attributes of passenger vehicles in Poland

Due date of deliverable: 28 February 2015

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We are very grateful for consultations and other help to following researchers:

Martin Kryl (instrument programming)
Eva Kyselá (data cleaning and coding)
Marie Kolmanová (presurvey, report editing)
Zuzana Martinková (presurvey, report editing)
Jan Novák (literature review on)
Maciej Wilamowski (passenger cars in Poland to set sampling)

and

Magdalena Fliśnik and Paweł Jurczyszyn from Millward Brown (pilot, data collection)

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Motivation

Electromobility is seen as part of strategy to reduce dependence of the European Union on oil and other fossil fuels, improve air quality, reduce noise in urban/suburban agglomerations, and contribute to a CO_2 reduction (Directive 2014/94/EU). The Directive 2014/94/EU sets that each Member State shall **adopt a national policy framework for the development of the alternative fuel market** and submit to the Commission a report on its implementation that should among others describe the policy measures taken in a Member State to support the deployment of the alternative fuel vehicles, including electricity driven vehicles. To prepare a national policy framework and to encourage the development of the alternative fuel market, among others, **understanding of consumer behaviour and preferences** for alternative fuel vehicles is crucial.

Objectives

For these reasons, the objectives of our research carried out in this project are:

i) **to** identify **factors influencing purchase of** electricity driven vehicles, and

ii) **to** examine **consumer preferences and estimate willingness to pay for** three electricity driven vehicles, specifically hybrid (HV), plug-in hybrid (PHEV) and electric vehicles (EV).

Methods and data

Consumers demand for certain goods can be modelled using existing data on market penetration or consumption decisions (revealed preferences). However, if the supply of certain durable goods is constraint or almost zero as is the case for new or not yet existing technologies, potential demand can be examined using **stated preference methods**. The main aim of our survey is to analyse consumers preferences for transport-relevant durables that are recently characterized by negligible or zero market penetration. In other words, individual preferences are elicited and demand for passenger cars with alternative driven technologies and for transportation-specific innovations are estimated. To fulfil these objectives a **discrete choice experiment** is conducted to elicit **consumers preferences for several vehicle attributes**.

In our discrete choice experiments, respondents are asked to choose their preferred car from **four types of cars (conventional, electric, hybrid car and hybrid car with plug-in)** described by a set of six attributes (Hanley et al., 2001; Bateman et al., 2004). The cars differ from one another in the levels of several attributes. **Purchasing price** of a car is one of the attributes, which allows us to estimate marginal willingness-to-pay for specific attribute of a vehicle. Except price, further attributes are: **operational and fuel costs, driving range, refuelling / recharging time, availability of fast-mode recharging infrastructure, and additional benefits** such as free parking or free public transport.

Quota sampling was used to draw **a representative sample of the Polish adult population** in terms of several socio-demographic characteristics (853 respondents) and a sample who **intend to buy a passenger car** within next three years (1760 respondents). The survey took form of structured computer-assisted web interviews by using an e-panel well managed by Millwardbrown, Poland. In total, **2613** Polish inhabitants were interviewed. This survey is **the first on this topic and using stated preference method in Poland and in Central and Eastern Europe**.

Results from the study in Poland

Identification of **triggers and barriers of purchase of low carbon vehicles and car-sharing in Poland**

- Most of people who intend to buy a vehicle within 10 years have already heard about electric or hybrid vehicles (87% or 83%), however, hybrid vehicles with plug-in are much less known (64%).

- Only 27% of consumers have ever considered buying an electricity driven vehicle, most of them hybrid and then hybrid with plug-in (33% and 29%).

- Under current conditions – and prior detailed information on alternative fuel vehicles were provided to a respondent – only small share of respondents informed us about their plan to buy an alternative vehicle (5% CNG, and 2% electric or hybrid car).

- Narrower assortment than of conventional vehicles, lack of service places, and poor availability of public charging stations in Poland are considered important barriers for their potential purchase of electric vehicle. Electric vehicles are then generally perceived as less noisy. People tend to believe that if they buy an electric vehicle they will contribute to lowering of CO_2 emissions and air pollution in cities and towns. However, these advantages of electric vehicles are not among the most important factors when deciding on car purchase. Rather, more likely low failure rate, car safety, fuel efficiency, maintenance and fuel costs, car equipment, interior space and purchase price are more decisive factors of car choice.

- About a quarter of our respondents have heard about car-sharing or car-pooling systems, and higher share of them has used the former rather than the latter system. Lowering the cost of car-sharing, for instance, by providing a tax rebate on fuel or electricity used for recharging a car, could motivate Polish travellers to use this system more. As a result of our contingent scenario, we find that car-sharing system using EVs only seems to be potentially widely exploited than the system merely relying on conventional vehicles.

- The results providing above are based on the representative sample of the Polish adult population.

Estimation of willingness-to-pay of Polish consumers for hybrid, plug-in hybrid and electric vehicles

- We asked respondents to imagine that a public program is introduced and slow mode charging sockets with electricity use meters would be installed that would allow **recharging an electric or plug-in hybrid vehicle in the place where they usually park** their car, even if they don't own a garage. Under this scenario, still preferences of Polish consumers for hybrid and electric vehicles were **significantly lower than their preferences for a conventional vehicle**. Respondents are more likely to buy hybrid plug-in cars, then hybrid, and consider electric vehicles as the most (unfavorably) different to conventional cars. We note, however, that there is considerable preference heterogeneity with respect to these car labels, and a substantial share of the population would have more positive preferences for the alternative fuel vehicles.

- We estimate both a simple multinomial logit model and a mixed logit model which is superior in being able to take **the respondents' unobserved heterogeneity** into account, i.e. it does not assume that every respondent has exactly the same preferences. In the summary, we report results for mixed logit model estimated for three segments of households defined according to what car they plan to buy (a new car, used car, or are not decided yet). Pooled data from both samples are used, only respondents who plan to buy a car answered the questions.

Estimation results – Mixed Logit for three household segments, WTP-space (example)

	new car	used car	undecided	pooled data
HV	-19 750 zł	-13 469 zł	-12 054 zł	- 17 116 zł
PV	-9 643 zł	-10 807 zł	-8 898 zł	- 12 726 zł
EV	-29 251 zł	-17 651 zł	-29 727 zł	- 26 272 zł
Operational costs	-48 408 zł	-24 021 zł	-44 224 zł	- 381 zł
Driving range (in 100km)	1 418 zł	1 145 zł	1 344 zł	1 522 zł
Recharging time (in hours)	-1 080 zł	-524 zł	-1 250 zł	- 940 zł
Free public transport	1 705 zł	1 010 zł	622 zł	1 387 zł
Free parking	3 043 zł	1 887 zł	2 420 zł	2 298 zł
Medium fast-mode recharging infrastructure	6 666 zł	4 728 zł	6 137 zł	5 562 zł
High fast-mode recharging infrastructure	7 507 zł	6 105 zł	12 235 zł	8 579 zł

Note: All coefficients are significant at 1% level, except the coefficients for free public transport that is significant at 5% level (new car) or not significant at any convenient level (undecided).

- **Driving range** is important attributes of a passenger car which Polish consumers intend to buy. On average, Polish drivers are willing to pay about 1,500 zł for each additional 100 km of driving range. Drivers who intend to buy a second-hand car value the driving range less than consumers who intend to buy a new car.

- **Recharging time** and **availability of fast-mode charging stations** are currently the most important barriers to larger spread of electric and plug-in hybrid vehicles. On average, Polish drivers are willing to pay slightly less than 1,000 zł for each hour saved for recharging. Those who intend to buy a new car are again willing to pay twice than what second-hand car buyers. Preference for AFVs markedly rose, when **availability of fast-mode recharging** improved from low level (20% of fuel stations + at few public places) to medium level (60% of fuel stations + at half of public places) or even high level (90% of fuel stations + at almost all public places). Corresponding willingness to pay for medium or high availability of fast mode recharging infrastructure is about 5,600 zł and 8,600 zł, respectively.

- Providing other benefits, such as **free parking** and **free public transport**, increases the probability to choose the AFVs. Average WTP is 2,300 zł and 1,400 zł, and again new car buyers are willing to pay more than second-hand buyers.

- Results of the mixed logit models indicate that consumer preferences for AFVs and their characteristics are highly diverse. An interaction model reveals that **higher levels of income** increase probability to purchase HV and PHEV and weaken the effect of operational cost attribute. Effect of income on other attributes seems to be not significant. Having at least one child in a family reduces importance of other benefits (public transport and parking).

- **Larger vehicle engine size** reduces probability to buy an EV and in general reduces WTP value for all vehicle attributes due to lowering coefficient on purchasing price (marginal utility of income). Larger engine size increases importance of driving range, recharging time and parking for free. **The longer mileage** that a consumer expects to drive, the higher WTP for HV and PHEV and the lower WTP for EVs. And the more kilometres a respondent intend to drive, the more important operational costs are. On the other hand, driving more leads to considering the purchase price less.

- Using the estimation results and simulating the effect of purchase price and operational costs on the probability to choose specific vehicle, the price elasticities for various household segments were derived.

- We find that **low educated respondents** are most sensitive to **purchase price of CV**, while this elasticity has the lowest value among more educated respondents who are rather most responsive to price changes of EVs, followed by price changes of HVs. On average, the highest price elasticity is estimated for price changes of EVs, especially among households living in **urban and suburban area**.

- Regarding the **operational costs**, **low educated** respondents are almost **insensitive to the cost changes**. Again the largest elasticity with respect to operational costs is estimated for EVs. Respondents **living in rural area** are then more sensitive on the cost changes than the respondents living in suburban and urban areas. These results also hold for changes in operational costs at lower levels that reflect rather fuel costs.

Results from the literature review

The stated preference methods, especially discrete choice experiments, serve as useful tool to **elicit preferences for very specific attributes of alternative fuel vehicles** and thus provide support for policy and help to forecast **market potential** for new technologies and their share. Even hypothetical levels of attributes can be included in the discrete choice experiments, such as the driving range of the electric vehicle that is better than any available on present-day's market, in order to examine **consumer preferences for such technological improvement**.

The fuel types of the vehicles introduced to respondents in the discrete choice experiments reflect current and also possible technologies in concerned countries. In most of the studies, there is one side a **conventional vehicle** represented by petrol (or additionally by diesel), the other fuel types, such as compressed natural gas (CNG), liquefied petroleum gas (LPG)), and on the other side low carbon vehicles represented by **hybrid, electric or hydrogen vehicles**.

Most of the studies provide the willingness to pay estimates for different attributes. There is **not sufficient evidence whether consumers would prefer AFVs** to conventional vehicles. Consumers' preferences depend on both **i) characteristics of the respondents**, and **ii) characteristics of the vehicles**.

i) The **willingness to pay values** vary not only among the countries, but WTP values also vary across household segments due to observed or unobserved preference heterogeneity.
The evidence on the effects of **sociodemographic variables is far to be conclusive**, it is country and study specific. However, several studies found that early adopters of AFVs **are more likely**:
   - home owners and those who live in detached or semi-detached family homes;
   - people owning more than one vehicle;
   - higher educated, younger to middle aged, higher income, environmentally conscious.

ii) **Preference and hence willingness to pay for AFVs:**
   - **increases with** the length of driving range, fuel availability (such as percentage share of fuel stations), car performance (such as engine power), greenhouse gas emissions reduction, policy incentives (such as remission of vehicle tax, free parking, bus lane access);

- **decreases with** length of charging (refuelling) time, purchase (capital) costs, fuel and maintenance costs.

Short driving range and long battery charging time are very important barriers of purchase of AFVs because both bring significant dis-utility to car buyers.

- Marginal utility of increasing driving range by 1km ranges about 10 to 60 EUR per a car.
- Utility from reducing battery charging time by one minute lies in similar range, however, the disutility related to refuelling hydrogen vehicles is larger compared to the disutility from battery charging of electric or plug-in hybrids. Consumers are willing to pay more if they do not have to refuel their vehicle every day but only every other day, or even once a week.
- The barriers associated with driving range and charging time seem to be the main reason why people tend to **prefer hybrid technology over electric vehicles** Because of the limited driving range of electric cars these are perceived as **insufficient for special journeys such as holidays or weekends away**. Alternative mobility options for "long journeys" are therefore needed to enhance the acceptance of electric vehicles.

In order **to achieve higher market shares** of AFVs,

- **taxation of conventional gasoline and diesel vehicles** or a **subsidization of AFVs** could be successful in promoting hybrid, hydrogen and electric vehicles. A study carried out In Denmark has shown that AFVs with present technology could reach fairly high market shares, if tax regulations that are applicable in the present vehicle market are utilized;
- **alternative mobility options for "long journeys",** such as public transport or different car rental, sharing or pooling systems, should be supported;
- **installing refuelling infrastructure** and increasing the visibility of refuelling stations;
- **policy incentives**, such as **access to bus lanes or free city parking**, could be introduced to reduce the obstacles for buying electric car, however, it seems that the utility related to these incentives would **not be strong enough** to motivate for increasing electric car penetration in the fleet **without improving driving range and battery charging**. The **remission of vehicle tax** was in one study valued higher than free parking;
- **research and development**, especially focused on improving driving range and battery charging, needs to be promoted;
- **marketing strategies** that would target **younger, higher educated, environmentally conscious consumers** can be utilized and effective.
- Media messages should raise the awareness among people about the positive consequences of AFVs adoption, such as the **environmental and energy security benefits, such as political independence from oil producing countries, and benefits deriving from local traffic policies** (free access to the town centre, free parking)**.**
- As AFVs are still at an **early stage of diffusion**, therefore **information on what** for example hybrid **vehicles offer**, except of financial and environmental benefits also affective and **practical information**, such as **quietness and spaciousness,** should be provided.

1 Introduction

Electromobility is seen as part of strategy to reduce dependence of the European Union on oil and other fossil fuels, improve air quality, reduce noise in urban/suburban agglomerations, and contribute to a CO_2 reduction (Directive 2014/94/EU). Electric vehicles should be also integrated to smart grid to contribute to the stability of the electric grid by recharging batteries in case of low demand and in more distant future to feed power from the batteries back into the grid in case of high demand (Directive 2014/94/EU).

Directive 2014/94/EU of the European parliament and of the Council sets that each Member State shall adopt a national policy framework for the development of the alternative fuel market and the relevant infrastructure and submit to the Commission a report on its implementation that should among others describe the policy measures taken in a Member State to support build-up of alternative fuels infrastructure, such as direct incentives for the purchase of means of transport using alternative fuels or for building the infrastructure, availability of tax incentives to promote means of transport using alternative fuels and the relevant infrastructure, use of public procurement in support of alternative fuels, including joint procurement, and demand-side non-financial incentives, for example preferential access to restricted areas, parking policy and dedicated lanes, etc. To encourage the development of the market for alternative fuel vehicles, including electricity driven vehicles, effective policy measures should be carefully selected, proposed and implemented.

To prepare a national policy framework for the development of the alternative fuel market, among others, **understanding of consumer behaviour and preferences** for alternative fuel vehicles is crucial.

This report contributes to knowledge about preferences of **Polish consumers** for three electricity driven vehicles, specifically **hybrid (HV), plug-in hybrid (PHEV)** and **electric vehicles (EV)** with three main types of results based on an **original stated preference survey conducted in Poland**:

1. Identification of **triggers and barriers of purchase** of electricity driven vehicles and car-sharing in Poland;
2. Estimation of **willingness-to-pay** of Polish consumers **for electricity driven vehicles and for specific attributes of passenger vehicles and incentives,** such as **supporting availability of fast-mode charging, free parking** and **public transport** for family members for free;

This report summarizes the main characteristics and findings of the survey. Specific objectives of this report are:

1) to provide a review of empirical literature on consumer preferences for alternative fuel vehicles (see Chapter 2);
2) to introduce theories that we utilize in our survey, particularly: i) the socio-psychological theoretical framework of reasoned action approach (Fishbein 2010), and ii) economic approach, especially the random utility theory (McFadden, 1974) (Chapter 3).
3) to describe valuation and econometric methods utilized in this study (Chapter 4), the questionnaire development and its structure (Chapter 5), an original stated preference survey, data gathering (Chapter 6) and datasets by descriptive statistics (Chapter 7);
4) to estimate willingness to pay (WTP) of Polish consumers for hybrid (HV), plug-in hybrid (PHEV) and electric vehicles (EV) and for specific attributes of passenger vehicles (see Chapter 8).

2 Literature review on preferences for alternative fuel vehicles (state-of-the-art)

With the onset of alternative fuel vehicles (AFVs) on the market, large amount of studies focusing on consumer preferences for AFVs have been already conducted worldwide. Consumers' demand for vehicle described with several specific characteristics can be modelled using existing data on market penetration or consumption decisions, i.e. through analysis of revealed preferences. However, if the supply of certain durable goods is constraint or almost zero as is the case for new device or not yet existing technology, potential demand can be examined using stated preference methods. In our case, the main aim of this chapter is to review literature on individual consumer's preferences for passenger vehicles, specifically for vehicles that is recently characterized by negligible market penetration. In other words, the stated preferences, as elicited via stated preference surveys, for cars with alternative drive technologies are examined.

2.1 Characteristics of the studies

The first discrete choice experiments on clean-fuel vehicles have been undertaken already in early 90's (Bunch et al., 1993; Kurani et al., 1996; Golob et al., 1997; Brownstone, Train, 1999), the pioneering work took place predominantly in United States. Our list consists of twenty seven studies and the vast majority of studies has been published since 2011. Nevertheless, some authors such as Daziano and Chiew (2012), Caulfield et al. (2010) or Mabit and Fosgerau (2011) worked with data that were collected much earlier and thus may seem outdated at the time of the publication, since the progression in AFVs technologies was rapid. The most recent research on preferences for AVF is undertaken under the ERA-NET DEFINE project. Within this project, questionnaire surveys were conducted in Austria (Stix, Hanappi, 2013) and in Poland (see results in chapter 7).

The surveys that we included in our literature review were usually targeted on recent or potential car buyers. Hoen and Koetse (2012) included only those members of surveyed households that drive the car most frequently, Dagsvik et al. (2002) and Lebeau et al. (2012) targeted general public, Golob et al. (1997) and Chorus, Koetse, Hoen (2013) focused on private companies.

The authors most often used computer-assisted survey methods, either personal interviewing (i.e. CAPI), or web interviewing (CAWI). Link et al. (2012) conducted telephone interviews (CATI) followed by a face-to-face interviewing (PAPI), Golob et al. (1997) and Bunch et al. (1993) conducted interviews by mail (post).

Except three quite small scale studies that interviewed 168, 250 and 274 respondents (Caulfield et al. 2010; Shin, 2012; Link et al., 2012), the sample size of majority of all studies ranged between 300 and 900, and in the remaining studies the sample had quite generous size, more than 1,000 respondents. Three tables below describe the key characteristics of 27 empirical studies on consumer preferences for AFV that we reviewed.

Table 1: Literature review – key characteristics of studies

	Location	Survey year	Survey method	Respondents	Target population	Choice tasks	Profiles	Attributes
Bunch et al. (1993)	United States	1991	POSTAL	343+367	random	5	3	6
Kurani et al. (1996)	United States	NA	CAWI - EMAIL SURVEY	454	owns two or more vehicles	1	2	7
Golob et al. (1997)	United States	1994	CATI + POSTAL	2023	fleet sites	according to fleet size	3	6
Brownstone, Train (1999)	United States	1993	CATI	4747	general public	NA	3	6
Brownstone, Bunch, Train (2000)	United States	1995	CATI	607	vehicle purchase since first SP inverview	1	3	9
Ewing, Sarigollu (2000)	Canada	NA	CAWI - EMAIL SURVEY	881	regular drivers	9	3	10 - 12
Dagsvik et al. (2002)	Norway	1995	CAPI	642	general public	15	28	10 - 12
Horne, Jaccark, Tiedemann (2005)	Canada	2002-2003	CAWI - EMAIL SURVEY	886	cities with population over 250000	4	3	3
Axsen (2007)	Canada, United States	2002-2006	CAWI - WEB SURVEY	544+422	gasoline vehicle owners	18	3	4
Potoglou, Kanaroglou (2007)	Canada	2005	CAWI - WEB SURVEY	426	prospective buyers	8	3	6
Caulfield et al. (2010)	Ireland	2000	CAWI - EMAIL SURVEY	168	recent buyers	6	3	8
Hackbarth, Madlener (2011)	Germany	2011	CAWI - WEB SURVEY	711	prospective buyers	15	3	8
Hidrue et al. (2011)	United States	2008-2009	CAWI - WEB SURVEY	3029	over 17 years	2	2	3
Mabit and Fosgerau (2011)	Denmark	2007	CAWI - WEB SURVEY	2146	new-car buyers	12	3	6
Qian, Soopramanien (2011)	China	2011	CAWI - WEB SURVEY + PAPI	527	random	8	3	8
Achtnicht (2012)	Germany	2007-2008	CAPI	598	prospective buyers	6	NA	4 of 8
Daziano, Chiew (2012)	United States	2000	CAWI - WEB SURVEY	500	prospective buyers	15	4-5	6
Hoen, Koetse (2012)	Netherlands	2011	CAWI - WEB SURVEY	1802	own one or more vehicles	8	3	7
Lebeau et al. (2012)	Belgium	2011	CAWI - WEB SURVEY	1197	over 18 years	10	2	6
Link et al. (2012)	Austria	2011	PAPI	274	prospective buyers	8	3	5

Shin (2012)	South Korea	2009	CAPI	250	own one or more vehicles	NA	4	4
Ziegler (2012)	Germany	2012	CAPI	598	prospective buyers	6	7	5
Daziano (2013)	United States	2000	NA	500	NA	up to 15	7	6
Chorus, Koetse, Hoen (2013)	Netherlands	2011	CAWI - WEB SURVEY	616	Company car leasers	8	3	8
Ida et al. (2013)	United States, Japan	2012	CAWI - WEB SURVEY	4202+4000	general public	8	6	7
Ito, Takeushi, Managi (2013)	Japan	2010	CAWI - WEB SURVEY	361	general public	8	30	9
Stix, Hanappi (2013)	Austria	NA	NA	714	new-car buyers	9	3	9
Our study	Poland	2014	CASI – web survey	2271	prospective buyers (sampled from general public and screened sample]	8	4	6

The number of experiments (choice tasks) each respondent attends varies widely among studies. Minimum amount of experiments in one (Kurani et al., 1996 and Brownstone, Bunch, Train, 2000), maximum is 18 (Axsen, 2007), since the majority studies conducted between 5 and 10 choice tasks. Several authors state that the optimum amount of experiments is eight, and that higher amounts may cause distortion. Predominant majority of studies lets the respondent to choose between 3 alternatives (profiles) within each choice task. Dagsvik et al. (2002) and Ito, Takeushi, Managi (2013) both attempt to simulate real decision making by allowing respondent to select within wide range of alternatives (28 and 30). Bunch et al. (1993), Hoen, Koetse (2012) and Mabit, Fosgerau (2011) allow the possibility to preserve the status quo and thus not select any of alternatives. An amount of attributes for each alternative differ significantly too, between 3 and 12.

Considering the location of the study, 11 studies were exercised in Western Europe, 13 studies in Northern America and 3 in Asia. No study has been conducted in the region of Central and Eastern Europe yet.

Fuel types of the vehicle introduced to respondents in the discrete choice experiments reflect current and also possible technologies in concerned study sites. As shown in table 2 in every study there is on one side a conventional vehicle represented by petrol (or additionally by diesel, compressed natural gas (CNG), liquefied petroleum gas (LPG)), on the other side the low carbon propellant represented by hybrid, electric or hydrogen fuel types.

Table 2: Fuel types of the vehicle introduced to respondents in the discrete choice experiments (DCE)

	Electric vehicle	Hydrogen vehicle	Hybrid vehicle	Petrol	Diesel	CNG	LPG
Bunch et al. (1993)	x			x		x	
Kurani et al. (1996)	x			x			
Golob et al (1997)	x			x		x	
Brownstone, Train (1999)	x			x		x	
Brownstone, Bunch, Train (2000)	x			x		x	
Ewing, Sarigollu (2000)	x		x	x			
Dagsvik et al. (2002)	x		x	x		x	
Horne, Jaccark, Tiedemann (2005)		x	x	x		x	
Axsen (2007)			x	x			
Potoglou, Kanaroglou (2007)			x	x		x	
Caulfield et al. (2010)			x	x		x	
Hackbarth, Madlener (2011)	x	x	x	x	X	x	X
Hidrue et al. (2011)	x			x			
Mabit and Fosgerau (2011)	x	x	x	x		x	
Qian, Soopramanien (2011)	x		x	x			
Achtnicht (2012)	x	x	x	x	X	x	
Daziano, Chiew (2012)	x		x	x			
Hoen, Koetse (2012)	x	x	x	x	X		X
Lebeau et al. (2012)	x		x	x			
Link et al. (2012)	x		x	x			
Shin (2012)	x		x	x	X		
Ziegler (2012)	x	x	x	x	X	x	
Daziano (2013)	x		x	x			
Chorus, Koetse, Hoen (2013)	x	x	x	x			
Ida et al. (2013)	x		x	x			
Ito, Takeushi, Managi (2013)	x	x	x	x			
Stix, Hanappi (2013)	x		x	x		x	
Our study	x		x (+PHEV)	x (no distinction bw petrol and diesel)			

Chorus, Koetse, Hoen (2013) included the flexi-fuel vehicles that run simultaneously on more than one fuel, i.e. gasoline and methanol. Some studies, e.g. Tanaka et al. (2013) differentiate – as we also do in our study – also between hybrid vehicles and plug-in hybrid electric vehicles, in this review we include it in one category.

Hoen, Koetse (2012) decided to exclude the conventional vehicle from 35% of choice tasks, such that 65% of choice tasks contained only alternative fuel vehicles. The main reason was that the conventional vehicle might be used as an “opt out” by many respondents, potentially leaving authors with a limited set of information leading to difficulties in obtaining reliable estimates.

Table 3: Attributes included in peer-reviewed choice experiments on consumer preferences for alternative fuel vehicles.

	Capital costs	Operating costs	Driving range	Fuel availability	GHG emissions	Charging time	Car perform	Incentive	Mainten. costs	Body type	Luggage space
Bunch et al. (1993)	x	x	X	x	x		x				
Kurani et al. (1996)	x		X				x				
Golob et al (1997)	x	x	x	x	x	x					x
Brownstone, Train (1999)	x	x	x	x	x	x	x				x
Brownstone, Bunch, Train (2000)	x	x	x	x	x	x	x				x
Ewing, Sarigollu (2000)	x	x	x		x	x	x	x			
Dagsvik et al. (2002)	x	x	x				x				
Horne, Jaccark, Tiedemann (2005)	x	x		x	x		x	x			
Axsen (2007)	x	x			x		x				
Potoglou, Kanaroglou (2007)	x	x		x	x			x	x	x	
Caulfield et al. (2010)		x			x			x			
Hackbarth, Madlener (2011)	x	x	x	x	x	x		x			
Hidrue et al. (2011)	x	x	x		x	x	x				
Mabit and Fosgerau (2011)	x	x	x			x	x				
Qian, Soopramanien (2011)	x	x	x	x				x			
Achtnicht (2012)	x	x		x	x		x				
Daziano, Chiew (2012)	x	x	x				x				
Hoen, Koetse (2012)	x	x	x	x		x		x			
Lebeau et al. (2012)	x	x	x	x	x	x	x		x		
Link et al. (2012)	x	x	x		x	x	x		x		
Shin (2012)	x	x		x					x		
Ziegler (2012)	x	x		x	x		x				
Daziano (2013)	x	x	x				x			x	
Chorus, Koetse, Hoen (2013)	x		x	x		x		x	x		
Ida et al. (2013)	x	x	x	x	x						
Ito, Takeushi, Managi (2013)	x	x	x	x	x					x	
Stix, Hanappi (2013)	x	x	x	x	x			x			
Our study	x	x	x	x		x		x			

The order of the attributes either remained the same throughout all choice tasks such as in Hoen and Koetse (2012), some authors such as Link et al. (2012) changed randomly the positioning of attributes to avoid order effects in the interviews.

Purchase capital costs were included in all studies with the exception of Caulfield et al. (2010). The operational (fuel) costs were included without exceptions, but with different definitions. Most authors such as Lebeau et al. (2012) defines operational costs as fuel costs per km, Hoen and Koetse (2012) include also monthly maintenance costs, Link et al. (2012) or Stix and Hanappi (2013) defines operational costs and maintenance costs as two independent variables.

Driving range of hybrid vehicles is expected as identical to the conventional vehicles', remaining AFVs have (and are expected to have in near future) a shorter driving range. The fuel station availability is defined as a percentage share on fuel stations, Hoen, Koetse (2012) define it as a time that is necessary to find the required fuel station.

Greenhouse gas emissions reduction by one or the other fuel type is in 7 studies considered as one of the DCE attributes. The results confirm the relevance of the attribute; however the inclusion of this attribute may be the source of hypothetical bias, when the respondents give a morally desirable answer.

Charging time may be also defined as a refuelling rate (e.g. Ewing, Sarigollu, 2000; Mabit, Fosgerau, 2011). Some studies included also attributes such as luggage space, expecting that the battery for EV may be spacious.

There are several measures tested in the studies, how governments may attempt to achieve higher share of AFVs on the market. Policy incentives consist of free parking (e.g. Ewing, Sarigollu, 2000), an access to express or bus lanes (e.g. Horne, Jaccark, Tiedeman, 2005) and a reduction or an abolishment of vehicle taxes (e.g. Caulfield et al., 2010).

Hoen and Koetse (2012) examine the hypothesis whether an increase in the number of available vehicle models, from which a consumer can choose when purchasing a new vehicle, have any effect, the results show that the effect is positive, but not substantial. Ito, Takeushi, Managi (2010) elicit values of WTP for the brand/manufacturer of the vehicle and find it significantly important.

2.2 Results of the literature review: willingness to pay for different characteristics of alternative fuel vehicles

The willingness to pay for different attributes is defined as a ratio of the estimated coefficient of attribute, β_x, to the one of capital costs (purchase price), β_p. We usually observe negative WTP values for operation (fuel) costs, GHG emissions, charging time, and maintenance costs. Positive WTP values are common for driving range, fuel availability, car performance, incentive policies, and luggage space. The values differ not only among the studies, but the values are distinct also within individual studies, for instance, the authors usually observe preference heterogeneity across socio-demographic characteristics. There are some studies (Hanappi et al. 2012), including ours, that aimed at analysing unobserved heterogeneity in consumer preferences.

In this section, we focus on the most interesting results that were in some cases unexpected. However, one should be careful about generalisations of the results based on a review of studies relying on different context, scenario or site characteristics. Specific descriptions of different samples, specific government policies, environmental consciousness of consumers and historical background in the country or region should be considered.

Kurani et al. (1996) found strong support for the "hybrid household hypothesis" that a driving range limit of one household's vehicle will not be an important barrier to the purchase of an EV by a potential hybrid household. Hypothesis is applicable on households that own two or more vehicles. 38% of the sample would have to choose an EV over conventional gasoline-fuel vehicle. Authors find no statistically significant relationships between vehicle choices and household's commute trip distances, longest weekly trips, or distances to critical destinations.

According to Golob et al. (1997), who focused on commercial fleet demand for AFVs, there are substantial differences among fleet market segments in terms of preference trade-offs for other vehicle attributes. The trade-off between range and capital cost is approximately 80 USD per mile. Reductions of tailpipe emissions were found to be a significant predictor of vehicle choice only for the government and school sectors. Higher capital or operating costs, or smaller vehicle range, can be compensated for by a larger number of alternative fuel service stations.

Results of Ewing and Sarigollu (2000) conclude that other critical fuel-rated variables (e.g., quiet engine, smooth acceleration) were omitted in the experimental design. Comparing with previous studies, Canadians have more positive relation to EVs and HEVs. Individual coefficient of refuelling rate did not have expected sign, it was probably due to inaccurate values in the choice experiment.
Dagsvik et al. (2002) states that alternative fuel vehicles appear to be fully competitive alternatives compared to conventional gasoline vehicles. In addition to purchase price, driving range seems to be the most relevant attribute. Unless the limited driving range for electric vehicles is increased substantially this technology will not be fully competitive in the market. Regarding electric vehicles, men are more reserved towards this technology than women.

Horne, Jaccark, Tiedemann (2005) used the elasticities to provide notion of relative importance of the attributes. Capital costs seem to carry the greatest significance followed by fuel costs and fuel availability. Authors used mode choice model for testing different commuting variants - vehicle (alone), vehicle (carpool), public transit, park and ride, walk or cycle. Attributes used were travel time, cost, pick-up/drop-off time, walking/waiting time, number of transfers, bike route access. The most important seems to be non-driving time, driving time and commuting costs.

Axsen (2007) introduces the diffusion theory and neighbour effect. The author states that dynamic preferences proved to be more realistic than static preferences in hybrid-electric vehicle market, due to current low share of AFVs on total market for all kinds of vehicles. Both theories predict that consumers' preferences will increase with higher penetration into the total market. When the government speculates about supporting new technology, non-financial attributes (e.g. regulation) may be more efficient than financial strategies (e.g. subsidies or taxes).

Potoglou, Kanaroglou (2007) derive that consumers are attracted to "tax-free purchase" incentives and to vehicles with significantly reduced emission levels. Free parking and permission to drive special lanes in the city (originally exclusively for vehicles with more than one passenger) do not affect preferences. Segmentation variables including gender, age, education level, household size and type were significant and revealed differences in preferences between segments.

In study of Caulfield et al. (2010) vehicle registration tax and CO2 emissions were not considered important attributes by the respondents, meanwhile fuel consumption was considered important.

Hidrue et al. (2011) derived that the propensity to buy an EV increases with youth, education, green life style, believing gas prices will rise significantly in the future, and with living in a place where a plug is easily accessible at home. Consumer preferences were driven more by expected fuel savings than by a desire to be environmentally friendly. Range anxiety, long charging time and high purchase price remain consumer's main concern about EV. Battery costs need to drop considerably if EVs are to be competitive without subsidy at current US gasoline prices. The United States' federal tax credit of $7500 is likely to be sufficient to close the gap between costs and the WTP if battery costs decline to $300/kWh, which is the cost level projected for 2014.

Hackbarth, Madlener (2011) stated that German car buyers are currently very reluctant towards AFVs, especially electric and hydrogen vehicles. Younger, highly educated, and environmentally conscious consumers, and to some extent also urban drivers of small cars with access to a parking lot equipped with a socket, are more prone to buy new vehicle technologies in general. Hence, marketing strategies could be tailored such that they target specifically these consumer groups for effectively increasing the adoption rates. Financial incentives as they are used in some European countries today, and also lobbied for by German car manufacturers, are found to be insufficient to significantly increase adoption rates.

Stix, Hanappi (2013) designed 4 future scenarios of demand for AFVs until 2050. Concerning on the socio-economic characteristics, age has a negative effect on purchase of AFVs, on the other hand income, education, daily usage, environmental awareness of respondents, high service station availability have positive effect.

Mabit, Fosgerau (2011) predict that consumers will be more likely to choose environmentally friendly AFVs in future in place of conventional vehicles. This may be interpreted as a sign of environmental concerns and/or a strategic signal about the valuation of pollution in the sample as a public good. The high registration tax in Denmark leaves room for government as large rebates to AFVs.

Qian, Soopramanien (2011) derived, similarly to other studies, that consumers are more likely to consider hybrid and conventional vehicles than electric vehicles. The parameters of government incentives such as cash subsidy, free parking or priority lane access are insignificant.

Following results of Daziano, Chiew (2012) consumers expect driving range parity between electric vehicles and gas vehicles. Consumers desire an electric battery with average range of 330 miles. Introducing transportation cost savings, consumers are willing to buy an electric car instead of a standard gas vehicle if, on average, the electric driving range equals at least 114 miles.

Lebeau et al. (2012) show future scenarios of EVs market shares in case when certain technological progress occurs (e.g. increase of EV's driving range from 100 to 200 km). By 2020, number of new purchases could rise to 5% for BEVs and 7% for PHEVs because of technological improvements and a decline in purchase costs. In 2030, electrified transport could attain a market share of 15% for BEVs and 29% for PHEVs.

Link et al. (2012) derived that cost attributes have a higher impact on the purchase decision than technical characteristics of vehicles. The outsized meaning assigned to range and charging time in public perception cannot be confirmed. Market penetration of medium-sized electric cars will be higher compared to small-sized car, hybrid cars have better market opportunities than electric cars.
Results of study by Ziegler (2012) support the notion that a taxation of conventional gasoline and diesel vehicles, or a subsidization of alternative energy sources and propulsion technologies could be successful directions to promote hybrid, hydrogen, and electric vehicles. In contrary to other studies the potential car buyers in Germany have a low stated preference for electric, hydrogen, and hybrid vehicles relative to conventional vehicles.

Achtnicht (2012) examined whether CO2 emissions per km is a relevant attribute in vehicle choices. Emissions performance of vehicle matter substantially, but its consideration varies heavily across the sampled population. Knowing people's preferences with respect to public goods generally helps do design effective and economically efficient policy instruments.

Hoen, Koetse (2012) derived that preferences for AFVs are substantially lower than those for the conventional technology. Limited driving range, long refuelling times and limited availability of refuelling opportunities are to a large extent responsible for these findings. These barriers are most substantial for the electric car and hydrogen (fuel cell) car. Average stated preferences for AFVs increase considerably when improvements in driving range, refuelling time and additional detour time are made. An increase in the number of available models from which a consumer can choose and measures such as free parking have a positive but not substantial effect. The results clearly show that, also when substantial improvements on these issues occur, average negative preferences remain. The fact, that most technologies are relatively unknown and their performance and comfort levels are uncertain, are likely contributing factors in this respect.

Ida et al. (2013) concludes that US consumers are more sensitive than Japanese consumers about fuel cost reduction and fuel station availability. Japanese consumers are more sensitive about driving range and emission reduction. Comparing four US states (California, Texas, Michigan, New York), WTP for fuel cost reduction varies significantly and is the greatest in California.

Chorus, Koetse, Hoen (2013) compared conventional linear-additive Random utility maximization model (RUM) and Random regret minimization model (RRM). Models generate rather different choice probabilities and policy implications. Regret-based model accommodates compromise-effect. It assigns relatively high choice probabilities to alternative fuel vehicles that perform reasonably well on each dimension instead of having a strong performance on some dimensions and a poor performance on the others. Joint use of the models may lead to more robust policy-development if policies are selected that perform well under both the RUM and RRM regime.

Ito, Takeushi, Managi (2013) derived that consumers' WTP for certain driving ranges increases with an increase in infrastructural development (introduction of exchangeable batteries, higher share of recharging stations), which is not consistent with the predictions. One possible reason for this is the effect of a change in the distance that respondents travel in their cars. If the infrastructure for an AFV is so inadequate that the consumer will switch to public transportation, the distance travelled in the AFV decreases, as does the value of the vehicle. In this case, the substitute relationship between cruising range and infrastructure improvement changes to a complementary relationship a cruising range increases. (= complementary relationship between the driving ranges of AFVs and the infrastructure established.)) The results indicate that infrastructural development of battery-exchange stations can be efficient when electric vehicle sales exceed 5.63% of all new vehicle sales.

2.3 Conclusion

The stated preference methods, especially discrete choice experiments, serve as useful tool to **elicit preferences for very specific attributes of alternative fuel vehicles** and thus provide support for policy and help to forecast **market potential** for new technologies and their share. Even hypothetical levels of attributes can be included in the discrete choice experiments, such as the driving range of the electric vehicle that is better than any available on present-day's market, in order to examine **consumer preferences for such technological improvement**.

The fuel types of the vehicles introduced to respondents in the discrete choice experiments reflect current and also possible technologies in concerned countries. In most of the studies, there is one side a **conventional vehicle** represented by petrol (or additionally by diesel), the other fuel types, such as compressed natural gas (CNG), liquefied petroleum gas (LPG)), and on the other side low carbon vehicles represented by **hybrid, electric or hydrogen vehicles**.

Most of the studies provide the willingness to pay estimates for different attributes. There is **not sufficient evidence whether consumers would prefer AFVs** to conventional vehicles. Consumers' preferences depend on **both i) characteristics of the respondents, and ii) characteristics of the vehicles**.

i) The **willingness to pay values** vary not only among the countries, but WTP values also vary across household segments due to observed or unobserved preference heterogeneity.

The evidence on the effects of **sociodemographic variables is far to be conclusive**, it is country and study specific. However, several studies found that early adopters of AFVs **are more likely**:

- home owners and those who live in detached or semi-detached family homes;
- people owning more than one vehicle;
- higher educated, younger to middle aged, higher income, environmentally conscious.

ii) Preference and hence willingness to pay for AFVs:

- **increases with** the length of driving range, fuel availability (such as percentage share of fuel stations), car performance (such as engine power), greenhouse gas emissions reduction, policy incentives (such as remission of vehicle tax, free parking, bus lane access);
- **decreases with** length of charging (refuelling) time, purchase (capital) costs, fuel and maintenance costs.

Short driving range and long battery charging time are very important barriers of purchase of AFVs because both bring significant dis-utility to car buyers.

- Marginal utility of increasing driving range by 1km ranges about 10 to 60 EUR per a car.
- Utility from reducing battery charging time by one minute lies in similar range, however, the disutility related to refuelling hydrogen vehicles is larger compared to the disutility from battery charging of electric or plug-in hybrids. Consumers are willing to pay more if they do not have to refuel their vehicle every day but only every other day, or even once a week.The barriers associated with driving range and charging time seem to be the main reason why people tend to **prefer hybrid technology over electric vehicles** Because of the limited driving range of electric cars these are perceived as **insufficient for special journeys such as holidays or weekends away**. Alternative mobility options for “long journeys” are therefore needed to enhance the acceptance of electric vehicles.

In order **to achieve higher market shares** of AFVs,

- **taxation of conventional gasoline and diesel vehicles** or a **subsidization of AFVs** could be successful in promoting hybrid, hydrogen and electric vehicles. A study carried out In Denmark has shown that AFVs with present technology could reach fairly high market shares, if tax regulations that are applicable in the present vehicle market are utilized;
- **alternative mobility options for “long journeys”,** such as public transport or different car rental, sharing or pooling systems, should be supported;
- **installing refuelling infrastructure** and increasing the visibility of refuelling stations;
- **policy incentives**, such as **access to bus lanes or free city parking**, could be introduced to reduce the obstacles for buying electric car, however, it seems that the utility related to these incentives would **not be strong enough** to motivate for increasing electric car penetration in the fleet **without improving driving range and battery charging**. The **remission of vehicle tax** was in one study valued higher than free parking;
- **research and development**, especially focused on improving driving range and battery charging, needs to be promoted;
- **marketing strategies** that would target **younger, higher educated, environmentally conscious consumers** can be utilized and effective.

- Media messages should raise the awareness among people about the positive consequences of AFVs adoption, such as the **environmental and energy security benefits, such as political independence from oil producing countries, and benefits deriving from local traffic policies** (free access to the town centre, free parking)**.**
- As AFVs are still at an **early stage of diffusion**, therefore **information on what** for example hybrid **vehicles offer**, except of financial and environmental benefits also affective and **practical information**, such as **quietness and spaciousness,** should be provided.

3 Theoretical framework

Microeconomic theory of (rational) consumer considers consumer's preferences and tastes –that underlie consumer choice– as given, exogenous (Jackson, 2005). As a consequence, underlying motivations for certain consumer choice are not examined within economic perspective at all. Social-psychological theories try to open 'a black-box' of underlying preferences in order to understand motivational factors of behaviour.

For this reason, we utilize both i) the socio-psychological theoretical framework of reasoned action approach (Fishbein 2010), and ii) economic approach, especially the random utility theory (McFadden, 1974). Both theories are briefly described in this chapter.

3.1 Economic Approach: Random Utility Model

The theoretical model is random utility model (McFadden 1974; Hanemann 1984) in that individual chooses the alternative with the highest indirect utility, V.

$$V_{ij} = \beta_0 + \boldsymbol{x}_{ij}\boldsymbol{\beta}_1 + \left(y_i - C_{ij}\right)\beta_2 + \varepsilon_{ij}$$

where x denotes the attributes of the good, y is the income of the individual, C is willingness to pay for the contingent good, the subscripts i and j denotes the individual and the alternative respectively. The coefficients β_1 is the marginal utility of the attribute, β_2 is the marginal utility of income, which need to be estimated.

Discrete choice model is used to estimate the probability for choosing the alternative. If the stochastic term, ε, is independently and identically distributed, having extreme value I distribution, the probability that respondent *i* chooses the alternative *k* out of K alternatives is

$$\Pr(k) = \frac{\exp(\beta_0 + \boldsymbol{x}_{ik}\boldsymbol{\beta_1} - C_{ik}\beta_2)}{\sum_{j=1}^{K} \exp(\beta_0 + \boldsymbol{x}_{jk}\boldsymbol{\beta_1} - C_{jk}\beta_2)}$$

This probability is a contribution to loglikelihood in a conditional logit

$$\log L = \sum_{i=1}^{n}\sum_{k=1}^{K} ch_{ik} \log \Pr(k)$$

where *ch* is a dummy indicator that equals to one if respondent selects the alternative k, and zero otherwise. The loglikelihood is maximized. Marginal willingness to pay is given as the negative of ratio between the coefficient of marginal utility of the attribute x and the marginal utility of income. The standard error around the mean WTP can be computed by use of the delta method or Krinsky-Robb method.

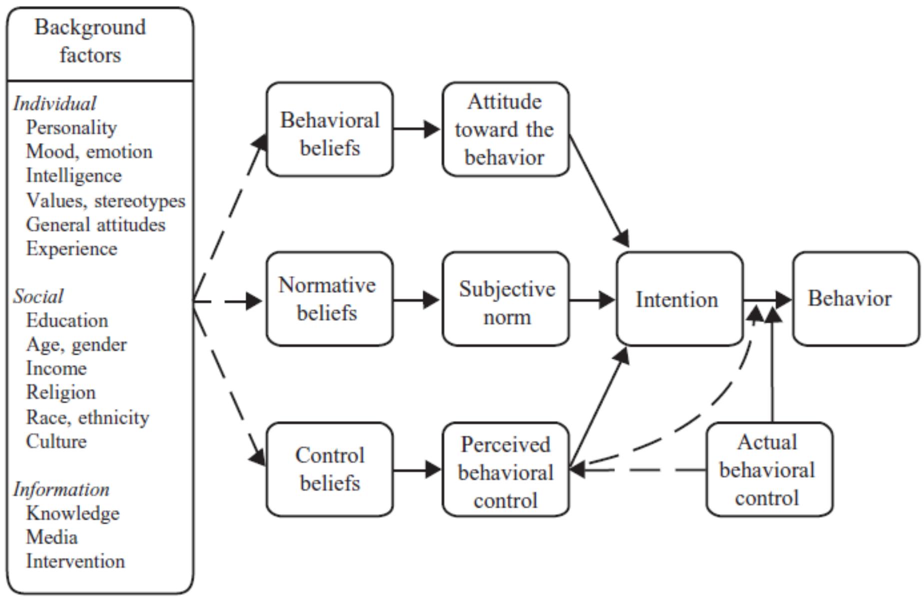
To allow heterogeneity in tastes among the respondents, the socio-demographic and other variables, including the internal factors (attitudes, subjective perception of norms, etc), enter into the logit via interactions with the attribute, i.e. multionomial logit.

The assumption of the independence of irrelevant alternatives (IIA) is implicit in both of these discrete models. In the case of outcomes that violate the IIA assumption, the estimates might be biased. Nested logit, GEV model, random parameter (mixed logit), or latent class logit models relax this assumption. We use random parameter model that allows capturing heterogeneity in the preferences across individuals (see Alberini, Ščasný, et al., 2012).

3.2 Social Psychological Approach: the Theory of Planned Behaviour

The theory of planned behaviour (TPB; see Figure 1) was proposed by Icek Ajzen (1985; 1991) as a modification of the earlier theory of reasoned action (Fishbein and Ajzen 1975). In order to improve prediction of behaviour that is under limited volitional control, Ajzen (1985; 1991) added to the theory of reasoned action a construct of perceived behavioural control and related beliefs. Thus, behaviour can be directly predicted from the intention to act and perceived behavioural control, i.e. perception of the factors facilitating or inhibiting performance of the behaviour. Perceived behavioural control can serve as a proxy for actual control to the extent that respondents are able to report accurately on these non-motivational factors (Icek Ajzen 1991; 2002). The intention to act is influenced by attitudes, subjective norms, and perceived behavioural control related to a given behaviour. Intention to perform the behaviour is stronger as attitudes and subjective norms towards behaviour are more favourable and perceived behavioural control is greater (Fishbein and Ajzen 2010, 21). Finally, the TPB presumes that attitudes, subjective norms, and perceived behavioural control are formed based on beliefs regarding the probable outcomes of the behaviour and their respective evaluations (behavioural beliefs), beliefs regarding whether significant others approve or disapprove the performing of the behaviour and motivation to comply with their expectations (normative beliefs), and beliefs regarding the existence and the perceived power of factors that may enable or inhibit realization of the behaviour (control beliefs) (Icek Ajzen 2002; Fishbein and Ajzen 2010).

Figure 1: The theories of reasoned action and planned behaviour



Source: adopted from Ajzen and Fishbein 2005, p. 194.

Several studies successfully applied the TPB to explain travel mode choice and car use (Abrahamse et al. 2009; Bamberg and Schmidt 2003; Bamberg 2006; Gardner and Abraham 2010; Heath and Gifford 2002; Verplanken et al. 1998). However, only one study (Klöckner, Nayum , and Mehmetoglu, 2013), as we know, employ the TPB to explain electric car purchase.

4 Methods

4.1 Valuation methods

One of the objectives of this study is to utilize stated preference methods to estimate willingness-to-pay of Polish consumers for alternative fuel vehicles described by specific attributes.

To understand ***consumers' choices among conventional and three types of alternative fuel vehicles*** we used the ***discrete choice experiment method***, specifically sequences of multinomial choice questions. The choice responses are assumed to be driven by an underlying random utility model.

In reality, several types of propellants for passenger vehicles are available on the market, including fossil-based fuels (gasoline, diesel, LPG, compressed natural gas), alternative fuels such as methanol or hydrogen, or more recently electricity. Based on the literature review and pre-survey, several key vehicle attributes were identified (e.g. size and type of vehicle, size of luggage space, fuel costs, refuelling time at home and at service station, service station availability, horsepower of vehicle engine or emissions).

In our discrete choice experiment, ***respondents were shown conventional car*** (fuelled by petrol, diesel, or oil derivatives such as LPG) and three types of electricity driven cars, specifically ***electric, hybrid car and hybrid car with plug-in, described by a set of six attributes, and were asked to choose their preferred car*** (Hanley et al., 2001; Bateman et al., 2004). The cars differ from one another in the levels taken by two or more of the attributes. Price (or cost to the respondent) is one of the attributes, which allows us to estimate marginal ***willingness-to-pay for specific attributes of vehicles***. Further attributes that we selected were: ***operational costs, driving range, refuelling / recharging time, availability of fast-mode recharging infrastructure, and additional benefits***, particularly free parking, free public transport. Attributes and their levels used to describe the contingent scenario in the discrete choice experiment are summarized in Figure 2 and Figure 3.

Two ***car-sharing systems*** were briefly described to respondents and they were asked to decide whether they ***would participate in these systems under given conditions***. We utilized single-bounded discrete choice question. One of the conditions was price of the service, specifically price per km driven or an additional fee per hour for using a car. Thus, we could estimate ***willingness-to-pay for using a car from the carsharing scheme***. Design of the single discrete choice for participation in the car-sharing system can be found in Figure 4.

Figure 2*:* Design of the choice experiment on alternative fuel vehicle preferences

Attribute	Type of variable	Unit	No. of levels
Purchase price	continuous	zloty	1 and 7
Operational costs	continuous	**OC(x)** zloty per 100 km (**OCM(x)** zl per month)	2 to 4
Driving range	continuous	max km	3 to 4
Refueling / recharging time	continuous	hh:mm	1 or 3
Availability of fast-mode recharging	categoric		3 NA (for CV,HV)
Other benefits	categoric		4 (NA for CV)
Free parking	categoric		2 NA (for CV)
Free public transport	categoric		2 NA (for CV)

Figure 3*:* Design of the choice experiment on alternative fuel vehicle preferences

Attribute/Label	CV	HV	PHEV	EV
Purchase price	P(CV)= midpoint(**QC5**)	-2=80%*P(CV) -1=90%*P(CV) 0=P(CV) 1=110%*P(CV) 2=120%*P(CV) 3=130%*P(CV) 4=140%*P(CV)	-2=80%*P(CV) -1=90%*P(CV) 0=P(CV) 1=110%*P(CV) 2=120%*P(CV) 3=130%*P(CV) 4=140%*P(CV)	-2=80%*P(CV) -1=90%*P(CV) 0=P(CV) 1=110%*P(CV) 2=125%*P(CV) 3=133%*P(CV) 4=145%*P(CV)
Operational costs	1: FF=25 & OC(CV)= 25+4000/(KM/100) 2: FF=30 & OC(CV)= 30+4000/(KM/100) 3: FF=40 & OC(CV)= 40+4000/(KM/100) 4: FF=50 & OC(CV)= 50+4000/(KM/100) OCM(CV)=(OC(CV)/100)*KM/12)	1= OC(HV)= FF{i}*.9 + 5000/(KM/100) 2= OC(HV)= FF{i}*1.0 + 5000/(KM/100) OCM(HV)=OC(HV)/100*(KM/12)	1: OC(PHEV)= FF{i}*0.7 + 5000/(KM/100) 2: OC(PHEV)= FF{i}*0.9 + 5000/(KM/100) 3: OC(PHEV)= FF{i}*1 + 5000/(KM/100) OCM(PHEV)=OC(PHEV)/100*(KM/12)	1: OC(EV)= FF{i}*0.25 + 2000/(KM/100) 2: OC(EV)= FF{i}*0.4 + 2000/(KM/100) 3: OC(EV)= FF{i}*0.75 + 2000/(KM/100) OCM(EV)=OC(EV)/100*(KM/12)
Driving range	1=500 2=700 3=900	1=500 2=700 3=900	1=500 2=700 3=900	1=150 2=250 3=350 4=500
Refueling / recharging time	1= 2 minutes	1= 2 minutes	1=3h 2=1h 3=30min	1=7h 2=4h 3=2h

Availability of fast-mode recharging	NA	NA	1 = low (20% of fuel stations + at few public places) 2 = medium (60% of fuel stations + at half of public places) 3 = high (90% of fuel stations + at almost all public places)	1 = low (20% of fuel stations + at few public places) 2 = medium (60% of fuel stations + at half of public places) 3 = high (90% of fuel stations + at almost all public places)
Other benefits	blank'	darmowe parkowanie' *(if ft=1 & fp=0)* 'darmowy transport publiczny' *(if ft=0 & fp=1)* 'darmowe parkowanie i transport publiczny' *(if ft=1 & fp=1)* 'brak' *(if ft=0 and fp=0)*	darmowe parkowanie' *(if ft=1 & fp=0)* 'darmowy transport publiczny' *(if ft=0 & fp=1)* 'darmowe parkowanie i transport publiczny' *(if ft=1 & fp=1)* 'brak' *(if ft=0 and fp=0)*	darmowe parkowanie' *(if ft=1 & fp=0)* 'darmowy transport publiczny' *(if ft=0 & fp=1)* 'darmowe parkowanie i transport publiczny' *(if ft=1 & fp=1)* 'brak' *(if ft=0 and fp=0)*
Free parking	0='blank'	0=none 1=free parking	0=none 1=free parking	0=none 1=free parking
Free public transport	0='blank'	0=none 1=free public transport	0=none 1=free public transport	0=none 1=free public transport

Figure 4*:* Design of the single discrete choice for participation in the car-sharing system

Attribute	**Levels**
Type of the cars in the car pool	conventional cars using either diesel or petrol electric cars – both hybrid and plug-in
Price per km driven	20 groszy 40 groszy 60 groszy 1 zloty
Additional price per hour for using a car *(only for the second treatment group)*	2 zloty 3 zloty 5 zloty 15 zloty

5 The questionnaire

5.1 The structure of the questionnaire

The final version of the questionnaire, including contingent valuation scenarios, was prepared based on a pre-survey (11 semi-structured interviews) and pilot testing of previous version. The final questionnaire in Polish can be found in Appendix 2.

The questionnaire structure follows a common ordering (e.g. Bateman et al., 2004). However, a few questions on socio-demographic characteristics were placed in the beginning of the questionnaire to be able to monitor quota attainment, as recommended for computer-assisted web interviewing (CAWI).

Several randomised treatments have been programmed, specifically the rotation of the order of the questions on willingness to participate in the carpooling scheme that will provide either conventional vehicles or hybrid and electric vehicles. Further, we randomly ascribed whether a respondent valued a carpooling scheme where the price would depend strictly on how many kilometres would be driven or a carpooling scheme where the price would depend also on additional fee paid per hour for using a car from the pool (that would cover car maintenance costs and operating costs of the system). In the case of questions with several items (mainly attitudinal questions), we asked to rate the items in a random order.

The questionnaire was composed of 11 parts:

SECTION A. Personal characteristics of the respondent and the respondent's partner

In case of sample A, the first question was a screening question whether respondent or any member of the respondent's household intend to buy something from a list, which included an apartment, a house or common household goods such as a car, a motorbike or a moped, a washing machine, or a dishwasher, within the next 3 years or not. We let respondents to pick up those that are planning to buy from a list to avoid something similar to "yea-saying" bias grounded in this case in the motivation of participants of e-panels who would like to participate in the survey to get a bonus for filling out the questionnaire. When we provided a list, they couldn't know which items were subject of our survey. Only respondents who chose that they intend to buy a car could continue filling the questionnaire.

Both in case of sample A and B, socio-demographic characteristics of respondents were gathered to be able to monitor quota attainment to meet quota requirements. We included the questions on:

- education
- region of the residence
- size of the municipality
- gender
- age
- a steady life partner
- monthly net personal income after tax and compulsory deductions, from all sources

SECTION B. DRIVING HABITS

- holding a driving license
- frequency of driving of a respondent and household members

- frequency of short distance trips (up to 100 km one-way), medium-long trips (up to 500 km one-way), and long distance trips

SECTION C. Characteristics of car/cars that a household possess or can use

- number of cars in the respondent's household
- usage of a company car by the respondent's household
- to which vehicle segment the car belongs to
- purchase price of the car
- fuel or alternative technology that the vehicle uses
- engine size of the car
- how many kilometres was the vehicle driven in the last 12 months
- availability of parking at a garage at home and at workplace

SECTION D. Decision-making about purchase of a car

- intention to buy a car
- reasons for car purchase
- type of car
- expectations about purchase price, fuel or alternative technology, engine size, how many kilometres will be the vehicle driven per a year
- importance of various car characteristics for the purchase
- decision-making about technical parameters of the car in the household

SECTION E. Preferences for electric, hybrid car, and hybrid car with plug-in

As alternative fuel vehicles are still at an early stage of diffusion in many countries including Poland, we provided respondents with description of three types of electric driven vehicles and compared them to conventional car (see the following figure for information given in the questionnaire).

Figure 5**:** Definitions of cars as shown to respondents

1. Conventional car
drives on an internal combustion engine that can be fuelled by petrol, diesel, or oil derivatives such as LPG.

2. Electric car
is a vehicle set in motion by an electric motor and that is powered by electricity. It has a battery which can be recharged from a regular electric socket.

3. Hybrid car
is a vehicle with batteries but without a plug. It has both an internal combustion engine and electric one. The combination allows the electric motor and batteries to help the conventional engine operate more efficiently, reducing fuel use. Switching between the two engines occurs automatically without the driver's intervention. The battery is charged from the energy produced by a combustion engine during driving or while braking. A hybrid car drives several kilometres solely on electricity.

4. Hybrid car with plug-in
is a vehicle with an internal combustion engine (petrol or diesel) and its batteries can also be charged from a regular electric socket (like electric cars). The car can drive several tens kilometres solely on electricity. When the batteries are empty, the car automatically switches to the internal combustion engine.

Questions whether respondents have heard of alternative fuel vehicles and whether they considered buying these vehicles followed the information on vehicles not to lose respondent's attention.

Respondents then were asked to imagine that a public program would be introduced and slow mode charging sockets with electricity use meters would be installed, thus they would be able to charge an electric or plug-in hybrid vehicle in the place where they usually park it, even if they don't own a garage. In the discrete choice experiment, respondents should choose which of the introduced types of cars (conventional, electric, hybrid car and hybrid car with plug-in) they would buy. Respondents were also explained that the vehicles would differ only in 6 attributes, i.e. purchase price, operating costs, driving range, refuelling/recharging time, and availability of fast-mode recharging infrastructure for electric vehicles, and additional benefits provided to drivers of electric and hybrid vehicles. The next table summarises attributes of vehicles as presented to respondents.

Table 4: Attributes of the vehicles introduced to respondents in the discrete choice experiment

Attribute	***Description***
Purchase price	– *represents all one-time expenses associated with the purchase (including the price, taxes, registration fees, etc.).* – *The purchase price of alternative electric vehicles (electric, hybrid, and hybrid plug-in) can be lower in the future than it is now if government provides a subsidy to buy them or the alternative vehicles are exempted from an excise duty. The price of alternative vehicles can be also reduced due to technological progress.* – *On the other hand, the purchase price of conventional vehicles can be higher than it is now because of increased registration fee or if government will introduce new or revise current tax on vehicles that use fossil fuels.*
Operating costs	– *represent an average cost of driving 100 km (including all expenditures, such as the cost of fuel, maintenance and repairs, tires, technical checks, insurance and others.* – *Cost of fuel may be different in future due to shortage in worldwide supply or if environmental policy is introduced to reduce fossil fuel consumption and emissions. Therefore, operating costs will vary across the options we are going to show you.*
Driving range	– *represents the maximum distance that can be covered by a car after it is fully fuelled or charged.* – *If fully tanked, the conventional and hybrid vehicles may drive from 500 km up to 1,000 km.* – *Electric cars – with fully recharged batteries – can drive shorter distance from 150 km to approximately 500 km.*
Refueling / recharging time	– *is time required to refuel or recharge your car from empty to full. We are presenting several levels of slow mode of recharging electric or plug-in hybrid vehicles that ranges between 2h and 7 h for electric cars, and between 30 min and 3 h for a plug-in hybrid car.*
Availability of fast-mode recharging infrastructure (10 min electric car/5 min hybrid car)	– *Recently there are already known very fast recharging devices, which make recharging faster.* – *Recharging electric vehicle entirely takes only 10 minutes compared to 6 to 8 hours if recharged from an AC socket at home. Hybrid vehicle with plug-in can be then recharged within 5 minutes only.* – *The fast-mode charging stations can be available to users to various degrees. They can be located at some of existing petrol stations, for example, 20%, 60%, or 90% of petrol stations, or other frequently visited places (e.g. supermarkets, cinemas and sport stadiums).*
Additional benefits	*We would like to ask you to consider following two benefits you might get as a governmental support for promotion of purchase of alternative fuel vehicles:* – ***free parking** - those who would drive an electric or a hybrid car (with or without plug-in) might park their car at any public parking places in Poland for free,* – ***free public transport** - all family members of a person who owns an electric or hybrid car could use public transportation system, including railway or busses, and park-and-ride (PR) system fully for free.*

An example of a choice set that was presented to respondents is shown in the following figure. All respondents who indicated that they intend to buy a car within three years participated in the discrete choice experiment. In case of sample B (general population), also those who intend to buy a car within four to ten years were filled in the discrete choice experiment. Each respondent evaluated eight choice sets.

Figure 6: Example of the choice set for car purchase (The wording of the first question: “If you had to buy another car for your household and you would have only those 4 options, which car would you select?” The wording of the second and the third question: “Which car from the rest of cars do you consider the best for your household?”)

	Samochód hybrydowy z możliwością ładowania	**Samochód hybrydowy**	**Samochód elektryczny**	**Tradycyjny samochód**
Koszt zakupu	**103 500 zł**	**138 000 zł**	**92 000 zł**	**115 000 zł**
Koszty eksploatacji	**50 zł** na 100 km (**1042 zł** na miesiąc)	**47 zł** na 100 km (**979 zł** na miesiąc)	**31 zł** na 100 km (**646 zł** na miesiąc)	**46 zł** na 100 km (**958 zł** na miesiąc)
Zasięg samochodu	**700 km**	**700 km**	**150 km**	**500 km**
Czas tankowania / ładowania	**2 min / 3 godz.**	**2 min**	**2 godz.**	**2 min**
Dostępność infrastruktury szybkiego ładowania *(10 min elektryczny / 5 min hybrydowy)*	**niska** (**20%** stacji benzynowych + kilka miejsc publicznych)	-	**wysoka** (**90%** stacji benzynowych + większość miejsc publicznych)	-
Inne korzyści	brak	darmowy transport publiczny	darmowe parkowanie i transport publiczny	brak
Pierwszy najlepszy	**1.**			
Druga najlepsza		**2.**		

Który z pozostałych samochodów uważa Pan(i) za najlepszy z pozostałych dla swojego gospodarstwa domowego?

Wybór			○	○

dalej

SECTION F. De-briefing questions

Debriefing questions are put at the end of the valuation section to allow for an opportunity to express disagreement with the valuation scenarios (i.e. protest votes), and to identify whether certain response patterns are legitimate or imply protest. We also let respondents to indicate to what extent characteristics of the cars were difficult or easy to understand.

SECTION G. Motivations

Section G includes both direct and indirect measures of latent constructs of the Theory of planned behavior (TPB): intention, attitudes, subjective norms, and perceived behaviour control (Ajzen, 1985; 1991). At least two items were formulated to measure each of the TPB constructs. Rating scales, particularly seven-point bipolar adjectives scales, were employed. The direct measures were developed on the basis of the pre-survey. Bearing in mind the principle of correspondence of TPB constructs (Ajzen 1991, 2005), we have defined the target behaviour as ‘respondent‘s purchase of electric car when buying a car the next time’ and formulated indicators of all the TPB constructs accordingly.

SECTION H. ABOUT YOUR HOME AND TRAVEL HABITS

- type of house where the respondent live
- ownership of a house or a flat
- character of the area of the respondent’s residence
- commuting by different means of transport (frequency, purpose)
- perception of technological development

- awareness of consequences of private car use
- ascription of responsibility for negative environmental effects of car use

SECTION I. Willingness to participate in car-sharing systems

Two car-sharing systems were briefly described to respondents and they were asked to decide whether they would participate in these systems under given conditions (single-bounded discrete choice question). While the first car-sharing system consists only of conventional cars using either diesel or petrol, electric and hybrid cars are part of the second system (see Figure 7 for an example of the valuation scenario). We have shown respondents different prices of the service based on the design. The car-sharing systems also differed in approach to pricing; either price depended on per km driven or also on an additional fee per hour for using a car.

Figure 7: Descriptions of car-pooling and car-sharing systems with related single-bounded discrete choice questions

Car-pooling means that people who plan to drive by their car would offer a seat to others who will contribute the driver to cover fuel and operational costs. Taxi is not considered as carpooling. Car-pooling is also different from a scheme in that a group of people can – following certain conditions – share cars from a fleet that is common.

Car-sharing presents a scheme in that a group of people can share and use cars from a fleet that is common to each member who belong to the group.

Imagine that there is an opportunity to use car-sharing in your town.
In the car pool, there would be a conventional cars using either diesel or petrol of various sizes in the pool.

The price would depend strictly on how many kilometers you will be using a car from the pool. The price per km would be PRICE.

There would not be any membership to belong to the pool.

B10a Would you participate in this car-sharing system?
[1] Yes
[2] No
[88] I don't know

Now imagine that the fleet would offer different cars.
In the fleet, there would be electric cars – both hybrid and plug-in – of various sizes.
The price would depend strictly on how many kilometers you will be using a car from the pool. The price per km would be PRICE. There would not be any membership to belong to the pool.

B11a Would you participate in this car-sharing system?
[1] Yes
[2] No
[88] I don't know

***SECTION* J. Socio-demographic characteristics of respondents**

- household net monthly personal income
- social status (such as single, retired, student etc.)
- marital status
- number of household members
- number of children for several age categories
- number of employed and retired household members
- postal code

***SECTION K*. Perception of the respondent of the instrument**

Finally, a question whether the respondent perceives the information that was obtained from him/her in the questionnaire should be used for the formulation of policy measures or not and specific comments on the questionnaire are placed at the end of the instrument.

5.2 Programming the instrument

The final version of the instrument prepared for the pilot was programmed. In the final stage of the pre-survey, we tested whether the program worked properly, including screening and filter questions.

Due to the complexity of the instrument, we did not use any pre-programmed solution and decided to build our own instruments in-house. The instrument was based on PHP framework Nette 1.9 and database system MySQL, both being widely used web technologies. The Nette framework is particularly useful in creation and validation of form elements as well as in setting up basic security layers.

The core of the application allows for a branched design of the questionnaire and for splitting the respondents into multiple samples and, furthermore, it allows the respondents to pause and continue later on, even a couple of days later or from another computer. The system is also capable of real-time monitoring of pre-set socio demographic quotas to ensure an efficient data collection.

To allow for deeper analysis of the respondent’s behaviour or for the identification of intentional speeders, all actions of the respondents such as a page load and submission of answers, including unsuccessful submission of some answers (e.g. when not all required fields are filled in), is logged and can be reviewed in the phase of data analysis.

The front end of the application had to fulfil the following criteria: constrained to less than 1200px, usability on PCs as well as on tablets and cross-browser compatibility.

6 Data description

6.1 Data collection and sampling technique

The data exploited in this study comes from a ***questionnaire survey of the adult population of Poland***. The data were collected by Millward Brown in compliance with ICC/ESOMAR Code on Market and Social Research. The survey took the form of ***Computer-assisted web interviewing*** (CAWI). In total slightly more than **2 613 interviews** were carried out, including 407 interviews conducted in the pilot.

The online panel utilized for data collection

Millward Brown's online panel IBIS has been operating since 2006. The panel size at the moment is N=83 000 active respondents. An active panellist is a person who has taken part in at least one study in the preceding year.

Panel members are recruited through different channels: Field recruitment, Telephone recruitment, Internet recruitment, or Snowball method recruitment. The last method is applied when looking for respondents with unique features.

Millward Brown pays special attention to quality issues and accuracy of data collected through CAWI technique, in particular:

- Constant control of responses
- Uploading specific questions to verify if a respondent is able to listen / view questions containing sound/visual elements (multimedia test)
- Verification when was the last time the panellist took part in a survey – a standard assumed withdrawal period is 12 weeks (or 24 weeks for surveys on a similar subject). Withdrawal period minimizes the impact of participation in one survey on the results of another survey
- Uploading control questions to check the consistency of respondent's answers
- Recording every interval respondent made while completing the survey with an accuracy to each question displayed
- Recording the time respondent needed to complete the entire survey and the time required to answer each question (the results of too long or too short response times are checked).
- Putting a time lock that prevents from going too quickly through the survey questions (especially useful in case of audio or video materials)
- Eliminating or blocking responses signifying carelessness in completing a survey
- Securing a surplus of successes if we need to eliminate inconsistent data
- revising and updating data about respondents and excluding unreliable participants from future surveys or from the panel

All research projects carried out by Millward Brown comply with the ICC/ESOMAR Code on Market and Social Research and the ISO 20252 standard. Millward Brown's panel has also been certified with the ISO 26362 for access panels.

Millward Brown fully respects and abides generally applicable provisions of law, including the Civil Code, the Law on Personal Data Protection, the Law on Unfair Competition Law on Copyright and Related Rights.

The incentive system applied to Millward Brown's panel is a loyalty program. Panellists participating in studies gain points depending on time of the interview and the difficulty of the project. After collecting certain amount of points, each panellist can convert them into three kinds of prizes (vouchers for the online bookstore, phone recharges, money). The required number of points that can be exchanged is 1000 points which is an equivalent of 40 zlotys.

The full launch of the study is preceded by a soft launch. The purpose of beginning the study with sending a sample consisting of a small number of panellists is to check the correctness of data collection, incidence rate and the length of the interview. When the incidence rate has been verified, other samples are sent. The structure of each sample is adjusted to the structure ordered in the commissioning letter and each sample size is confronted with the degree of the quota fulfilment. The optimization of the sample is also possible by using the demographic information acquired in the recruitment process. The use of information about gender, age, location lets us send invitations to the groups missing during the data collection process. A segmentation of panellists concerning consumer characteristics takes place once a year.

Sampling strategy

Data consists of two independent samples.

1) Sample (A) consists of Polish respondents who ***intend to buy a passenger car within next three years.*** A screening question was placed just at very beginning of the questionnaire (see Appendix 2). Further, we set arbitrarily the shares of people who plan to buy a new or second-hand passenger car in order to have sufficient number of new passenger car buyers that will allow us to employ statistical analysis. One half of the respondents of sample A plan to buy a <u>new</u> passenger car (A1), while the second half of the respondents plan to buy a <u>second-hand</u> passenger car (A2) within next three years.
2) Sample (B) ***is representative of the general population of Poland in terms of several socio-demographic characteristics***. Respondents who plan to buy a new or second-hand passenger car are also a part of the sub-sample B. Respondents for sample A and for sample B were selected independently one on the other.

The samples were drawn from the populations using ***quota sampling*** with ***quotas for age, gender, region and size of place of residence***. In the case of ***sample B,*** the quota was based also on ***education.***

The collected raw data were cleaned. Incomplete cases were excluded. All logical conjunctions in the questionnaires were verified and approved. In both samples, some filter errors occurred in different individual cases, probably caused by respondents returning to previous questions and changing their answers. These cases were recoded to missing for given questions. The final sample sizes according to the phase of data collection (pilot or the main wave) are reported in the following table. In total, sample A consists of 1760 observations and sample B of 853 observations.

Table 5: Sample sizes for Sample A and Sample B

	Sample A	**Sample B**	**Total**
pilot	357	50	407
main wave	1403	803	2206
Total per sample	1760	853	2613

Representativeness

Sample B is representative of the adult population of Poland in terms of several socio-demographic characteristics. Regarding sample A, the main socio-demographic characteristics should be close to the population of people who bought a car in last 12 months. However, we cannot state that it is representative of population of people who plan to buy a car within next three years because the quotas were set using Target Group Index (structure of car drivers in Poland). Random sampling would be also problematic, because there is no sampling frame available for this subpopulation.

The idea behind collecting sample A is that this subsample can be used to boost sample B and increase efficiency of the estimates of population parameters derived from sample A. As a matter of fact, the proportion of Polish households who intend to buy a car in 3 years was not known before we conducted the survey and we rather assumed that it is relatively low. Our survey indicated that the share is 44 %. A large sample of observations of the general population or of the population aged 18 to 40 would be therefore needed to gain precise estimates of population parameters for households who intend to buy a car in near future.

The choice of data collection mode depends not only on research objectives but also on the available budget. Considering the total budget, we relied on CAWI to achieve the sample size, rather than on CAPI that would necessitate smaller sample treatments.

However, there is an important challenge for the Internet surveys: non-coverage (lack of Internet access or limited use) (Couper et al., 2007). First, certain social groups, typically the elderly, people in rural areas and people with low education (and income) could be under-represented. The issue of non-coverage of the general population is of different importance in different countries, depending on levels of Internet penetration in the country. However, this study is focused on Poland where the penetration of Internet users is high (94 % in 2013). Moreover, the review study of Lindhjem and Navrud (2011) found that the large majority of the SP studies that compare Internet with other modes find equal or lower WTP welfare measures for the Internet mode.

Time to fill the questionnaire and speeders

The actual median time of questionnaire completion was ca 34 minutes for sample A, 25 minutes for sample B. However, time needed to fill the questionnaire also differed according to answers to some important questions. For example those who have a car were asked additional questions about characteristics of the car (see Table 6). Those who completed the interviews in significantly shorter time than the others were identified and labelled as potential ‘speeders’ and moved to a separate data file. For the identification of speeders, we followed the recommendation of SSI (Survey Sampling International, 2013) to define as speeders those who complete the survey in 48 % of the median time. This definition of a speeder is used in all analyses carried out in this report.

Table 6: Median time of questionnaire completion according to subsamples

	Sample A (new car purchasers)	**Sample A (2hand car purchasers)**	**Sample B**
Household with a car, with INTENTION to buy	0:37:11	0:35:33	0:37:33
Household without a car, with INTENTION to buy	0:30:32	0:32:08	0:34:36
Household with a car, NO intention to buy	NA	NA	0:17:14
Household without a car, NO intention to buy	NA	NA	0:10:27

In sample B, 6 % respondents were classified as speeders and were removed from the dataset, resulting to total number of 800 observations (see Table 7). The cleaned dataset without speeders we labelled as “General population”, as it is representative of general populations. There were 5% of speeders in the sample A. Mostly datasets without speeders are further analysed in the following chapters.

Table 7: Number of observations in the sample representative of general populations and share of the speeders

	N (all)	**N (without speeders)**	**Percentage of speeders**
General population (Sample B)	854	800	6 %
People who intend to buy a car (Sample A)	1766	1675	5%

6.2 Comparison of statistics with the quotas

The comparisons of socio-economic and demographic characteristics of sample A and sample B with those of the target populations are shown in Table 8 and Table 9 .

The goodness-of-fit chi-square test indicates that the structure of the ***sample B*** is similar in terms of quota characteristics to the general population according to the data from the national census (see Table 9). Indeed, our sample is ***not statistically different from the target population*** in terms of ***gender, age, region, and household income***.

Regarding ***sample A***, ***quotas on gender, age, and region*** were set for both the pilot and the main wave data collections**.** However, because there is neither a sampling frame nor data on socio-demographic characteristics available for our target population, i.e. people who are planning to buy a car in 3 years; we set the quota on age and region based on ***data on car drivers in Poland*** (Target Group Index). The quota on gender was set arbitrary as the same share of males and females because only imprecise information is available. The share of males is 60% when car drivers are concerned in the Target Group Index and 46% if only panellists if some family member bought a car within last 12 months. Since there might be more females in the internet panel than males, the share of females from such families is larger than it should be, if the quota is based on household rather than personal characteristics. Still, we compared our dataset with the quota prescription (see Table 8). The achieved quotas were not statistically different from the original set up.

Table 8: Characteristics of the sample A (people who intend to buy a car) and target population

Gender	**Set up quotas**	**Proportion in the sample**	**Difference between proportion in the sample and in the population**	The goodness-of-fit chi-square test
Male	46 %	46 %	0%	1
Female	54 %	54 %	0%	
Age	**Set up quotas**	**Proportion in the sample**	**Difference between proportion in the sample and in the population**	
18-29 y.o.	26 %	26 %	0%	0,071953
30-49 y.o.	46 %	48 %	2%	
50+	28 %	25 %	-2%	
Region	**Set up quotas**	**Proportion in the sample**	**Difference between proportion in the sample and in the population**	
Centralny	21 %	20 %	0%	0,072834
Południowy	22 %	23 %	1%	
Wschodni	17 %	18 %	1%	
Północno-zachodni	15 %	15 %	0%	
Południowo-zachodni	10 %	11 %	1%	
Północny	16 %	13 %	-2%	

Source: Target Group Index (structure of car drivers in Poland)

Table 9: Characteristics of the sample B and target population (general population)

Gender	**Set up quotas**	**Proportion in the sample**	**Difference between proportion in the sample and in the population**	The goodness-of-fit chi-square test
Male	50 %	52 %	2%	0,288844
Female	50 %	48 %	-2%	
Age	**Set up quotas**	**Proportion in the sample**	**Difference between proportion in the sample and in the population**	
18-29 y.o.	24 %	25 %	1%	0,145471
30-49 y.o.	40 %	43 %	3%	
50+	36 %	33 %	-3%	
Size of municipality	**Set up quotas**	**Proportion in the sample**	**Difference between proportion in the sample and in the population**	
up to 20 000	52 %	49 %	-3%	0,259286
20 000 - 200 000	27 %	28 %	1%	
200 000 and more	21 %	23 %	2%	
Region	**Set up quotas**	**Proportion in the sample**	**Difference between proportion in the sample and in the population**	
Centralny	21 %	19 %	-2%	0,498991
Południowy	21 %	22 %	1%	
Wschodni	17 %	16 %	-1%	
Północno-zachodni	16 %	18 %	2%	
Południowo-zachodni	10 %	10 %	0%	
Północny	15 %	16 %	1%	
Education	**Set up quotas**	**Proportion in the sample**	**Difference between proportion in the sample and in the population**	
Primary and vocational	46 %	46 %	0%	0,662927
Secondary	35 %	36 %	1%	
Higher	19 %	18 %	-1%	

Source: Central Statistical Office of Poland

6.3 Attribution / allocation of the experimental design

The experimental design of our study consisted of 40 choice-tasks, each with 4 alternatives per respondent, blocked into 5 questionnaire versions; there were therefore 5 questionnaire versions (blocks) with 8 choice tasks per respondent. The order of choice tasks in each version, as well as the order of alternatives was randomized for each respondent, to mitigate potential anchoring or framing effects. The alternatives were labelled - each alternative represented a different fuel technology (conventional, hybrid, hybrid plug-in, electric). Since our respondents aimed at purchasing very different cars we used pivotal designs (Rose et al., 2008) - after eliciting main information about the car they intend to buy (new/used, price) and their expected use patterns (annual mileage) the attribute levels where made individual specific, i.e. they represented different (and alternative-specific) levels of deviations from the values expected by the respondent.

The design was optimized for D-efficiency (Sándor and Wedel, 2001; Ferrini and Scarpa, 2007) of the multinomial logit model using Bayesian priors (Huber and Zwerina, 1996; Scarpa and Rose, 2008). The efficiency was evaluated by simulation - we used a median of 1000 Sobol draws as an indicator of the central tendency (Bliemer et al., 2008). All prior estimates were assumed to be normally distributed, with the exception of the priors for alternative specific constants - which were assumed to be uniformly distributed to represent potentially larger heterogeneity of respondents' preferences with respect to propulsion technologies. The means of the Bayesian priors were derived from the MNL model estimated on the dataset from the pilot survey, and standard deviations equal to 0.25 of each parameter mean. The experimental design for the discrete choice experiment used in the main wave of data collection is described in the following table (Table 10).

Table 10: Frequency of variants of the efficient experimental design for the choice experiment on car purchase

Choice situation	cv.pp1	cv.oc1	cv.dr1	cv.rt1	hv.pp2	hv.oc2	hv.dr1	hv.rt1	hv.ft	hv.fp	hev.pp2	hev.oc3	hev.dr1	hev.rt2	hev.ft	hev.fp	hev.ai	ev.pp2	ev.oc4	ev.dr4	ev.rt3	ev.ft	ev.fp	ev.ai
1	QC5	25+4000*x	500	na	90%	100%+5000*x	500	na	free par	publtran	90%	100%+5000*x	900	3h	none	none	high	125%	40%+2000*x	250	4h	free parl	publtran	low
2	QC5	30+4000*x	500	na	110%	90%+5000*x	500	na	free par	none	90%	100%+5000*x	500	0.5h	none	publtra	low	125%	40%+2000*x	250	7h	free parl	none	medium
3	QC5	40+4000*x	500	na	100%	90%+5000*x	500	na	free par	publtran	130%	100%+5000*x	700	1h	free par	publtra	high	100%	25%+2000*x	500	7h	none	none	medium
4	QC5	40+4000*x	900	na	110%	90%+5000*x	500	na	none	none	130%	90%+5000*x	700	1h	none	none	low	90%	25%+2000*x	150	7h	free parl	publtran	high
5	QC5	50+4000*x	500	na	100%	90%+5000*x	900	na	none	publtran	100%	70%+5000*x	900	0.5h	free par	none	medium	145%	40%+2000*x	350	4h	none	none	low
6	QC5	50+4000*x	900	na	110%	90%+5000*x	500	na	none	none	100%	70%+5000*x	500	0.5h	free par	publtra	high	133%	40%+2000*x	350	4h	none	none	medium
7	QC5	50+4000*x	700	na	140%	100%+5000*x	700	na	free par	publtran	110%	70%+5000*x	900	3h	free par	publtra	low	110%	25%+2000*x	500	2h	none	none	high
8	QC5	25+4000*x	900	na	80%	100%+5000*x	500	na	none	none	130%	90%+5000*x	700	1h	none	publtra	medium	90%	75%+2000*x	350	7h	free parl	publtran	low
1	QC5	30+4000*x	500	na	90%	90%+5000*x	500	na	none	none	110%	90%+5000*x	900	1h	free par	publtra	medium	100%	75%+2000*x	150	4h	free parl	publtran	medium
2	QC5	30+4000*x	500	na	140%	100%+5000*x	700	na	free par	none	110%	70%+5000*x	500	3h	free par	none	medium	100%	75%+2000*x	150	2h	none	publtran	high
3	QC5	25+4000*x	700	na	130%	100%+5000*x	700	na	none	publtran	80%	100%+5000*x	900	3h	free par	publtra	medium	90%	25%+2000*x	150	2h	none	none	high
4	QC5	50+4000*x	700	na	120%	100%+5000*x	900	na	free par	publtran	90%	70%+5000*x	500	3h	none	none	medium	125%	25%+2000*x	250	2h	free parl	publtran	medium
5	QC5	30+4000*x	500	na	90%	90%+5000*x	900	na	none	publtran	130%	90%+5000*x	700	1h	free par	none	low	110%	75%+2000*x	500	2h	free parl	none	high
6	QC5	30+4000*x	900	na	120%	100%+5000*x	700	na	free par	publtran	120%	100%+5000*x	700	1h	free par	none	low	100%	25%+2000*x	500	2h	none	publtran	low
7	QC5	30+4000*x	700	na	130%	100%+5000*x	700	na	free par	none	130%	90%+5000*x	500	0.5h	free par	none	high	80%	40%+2000*x	150	7h	none	publtran	medium
8	QC5	25+4000*x	900	na	120%	100%+5000*x	700	na	none	publtran	80%	100%+5000*x	900	0.5h	free par	none	high	133%	40%+2000*x	350	4h	none	publtran	medium
1	QC5	40+4000*x	700	na	90%	100%+5000*x	900	na	free par	none	90%	70%+5000*x	500	3h	none	publtra	high	145%	40%+2000*x	350	4h	free parl	none	high
2	QC5	25+4000*x	900	na	90%	90%+5000*x	900	na	free par	publtran	80%	100%+5000*x	500	3h	none	none	low	110%	75%+2000*x	350	4h	none	none	low
3	QC5	30+4000*x	900	na	100%	90%+5000*x	900	na	none	publtran	140%	100%+5000*x	700	1h	none	publtra	low	80%	75%+2000*x	150	2h	free parl	none	medium
4	QC5	25+4000*x	700	na	80%	100%+5000*x	900	na	free par	none	140%	90%+5000*x	700	1h	free par	none	low	80%	75%+2000*x	500	7h	none	publtran	medium
5	QC5	30+4000*x	500	na	90%	100%+5000*x	900	na	free par	none	110%	70%+5000*x	900	0.5h	none	publtra	high	133%	40%+2000*x	250	4h	none	none	medium
6	QC5	40+4000*x	700	na	80%	90%+5000*x	900	na	none	none	120%	90%+5000*x	500	1h	free par	publtra	medium	125%	40%+2000*x	250	4h	free parl	publtran	low
7	QC5	40+4000*x	700	na	130%	100%+5000*x	700	na	none	publtran	90%	70%+5000*x	900	0.5h	none	publtra	low	80%	25%+2000*x	150	7h	free parl	none	low
8	QC5	40+4000*x	700	na	100%	90%+5000*x	900	na	none	publtran	140%	90%+5000*x	700	1h	none	publtra	high	90%	25%+2000*x	250	2h	free parl	none	medium
1	QC5	25+4000*x	500	na	140%	100%+5000*x	700	na	free parking	publtran	100%	100%+5000*x	900	3h	free parkin	none	high	100%	75%+2000*x	500	2h	none	publtran	low
2	QC5	30+4000*x	900	na	120%	100%+5000*x	700	na	none	publtran	110%	70%+5000*x	500	3h	free par	publtra	high	110%	75%+2000*x	250	2h	none	none	high
3	QC5	25+4000*x	900	na	130%	100%+5000*x	700	na	none	none	120%	100%+5000*x	700	1h	none	none	high	100%	75%+2000*x	500	7h	free parl	publtran	high
4	QC5	40+4000*x	700	na	80%	90%+5000*x	500	na	free par	none	140%	90%+5000*x	700	1h	free par	publtra	high	90%	75%+2000*x	150	2h	none	publtran	high
5	QC5	40+4000*x	900	na	100%	90%+5000*x	900	na	free par	none	120%	90%+5000*x	700	0.5h	none	publtra	medium	125%	25%+2000*x	250	7h	free parl	publtran	high
6	QC5	50+4000*x	500	na	100%	90%+5000*x	500	na	free par	publtran	100%	70%+5000*x	900	3h	none	none	low	145%	75%+2000*x	350	4h	none	none	medium
7	QC5	50+4000*x	500	na	120%	90%+5000*x	900	na	none	none	120%	90%+5000*x	700	0.5h	none	none	medium	125%	25%+2000*x	500	7h	free parl	publtran	high
8	QC5	40+4000*x	900	na	140%	90%+5000*x	700	na	none	none	80%	100%+5000*x	500	3h	none	none	medium	110%	25%+2000*x	500	2h	free parl	publtran	medium
1	QC5	40+4000*x	700	na	80%	100%+5000*x	500	na	none	publtran	80%	70%+5000*x	500	3h	free par	none	low	145%	40%+2000*x	250	4h	none	publtran	high
2	QC5	30+4000*x	500	na	140%	100%+5000*x	700	na	free par	publtran	90%	100%+5000*x	500	0.5h	free par	publtra	medium	80%	25%+2000*x	150	7h	none	none	low
3	QC5	50+4000*x	700	na	110%	90%+5000*x	900	na	none	none	120%	90%+5000*x	900	3h	none	none	high	90%	25%+2000*x	150	2h	free parl	publtran	low
4	QC5	50+4000*x	900	na	110%	90%+5000*x	500	na	free par	none	100%	70%+5000*x	900	0.5h	none	publtra	medium	145%	40%+2000*x	350	4h	free parl	none	high
5	QC5	50+4000*x	500	na	120%	90%+5000*x	500	na	free par	publtran	110%	70%+5000*x	500	0.5h	free par	none	high	110%	25%+2000*x	350	7h	none	publtran	low
6	QC5	50+4000*x	900	na	110%	90%+5000*x	500	na	none	none	100%	70%+5000*x	900	0.5h	free par	publtra	low	133%	40%+2000*x	250	4h	none	none	low
7	QC5	25+4000*x	500	na	130%	100%+5000*x	700	na	free par	none	80%	100%+5000*x	500	0.5h	none	publtra	low	133%	40%+2000*x	350	7h	free parl	none	high
8	QC5	25+4000*x	700	na	80%	100%+5000*x	500	na	none	publtran	140%	90%+5000*x	700	1h	none	none	medium	80%	75%+2000*x	500	2h	free parl	none	low

7 Descriptive statistics

7.1 Socio-economic characteristics

Tables 11 to 15 provide basic descriptive statistics for the main socio-demographic statistics of the representative sample of Polish population (N=853). There are even number of males and females (51.8% males). On average, there are 3.3 persons living in a family with 0.7 children. Only 6.2% present a single-occupied household. There are about 55.6% childless families.

About 66% of respondents are employed full-time or part-time and 10% are self-employed. About 16% are retired persons, but overall there are 31.8% families with at least one retired person. About 10% of respondents are recently unemployed, 12% are students and only 1% is taking maternity or parental leave (see Table 12).

Table 11: Descriptive statistics for sample of general population (original sample B)

	mean	std	min	max
number of household members	3.3	1.3	1	7
number of children in the household	0.7	1.0	0	5
number of retired people in the household	0.4	0.8	0	5
number of full-time employed people in the household	1.4	0.9	0	5
number of part-time employed people in the household	0.3	0.5	0	3

Table 12: General population: Employment status (multiple option)

employed - 30 hours per week or more	58%
employed - less than 30 hours per week	8%
self employed	10%
military service	1%
retired/pensioned	16%
housewife/husband not otherwise employed	7%
on maternity or parental leave	1%
student	12%
unemployed	10%
disabled	2%
other	9%

There are 6.3% respondents without any own income and median personal net income ranges between 1 800-2 299 zł per month (Table 13). Median household net monthly income ranges between 3 500 and 4 5000 zł, mean equals to 3 919 zł per month (Table 14). In both cases, there are about 12% respondents who would prefer not to answer.

Table 13: General population: Total monthly personal and household income

Personal income	
I have no income	6.3%
Less than 500zł	2.2%
Between 500-999 zł	6.5%
Between 1 000-1 799 zł	18.8%
Between 1 800-2 299 zł	18.2%
Between 2 300-3 299 zł	17.2%
Between 3 300-3 999 zł	7.5%
Between 4 000-4 999 zł	5.5%
Between 5 000-6 999 zł	4.6%
Between 7 000-7 999 zł	0.4%
Between 8 000-9 999 zł	0.4%
More than 10 000 zł i	0.5%
I would prefer not to answer	12.1%

Table 14: General population: Total monthly household income

Less than 500zł	1%
500-999 zł	2%
1 000-1 799 zł	9%
1 800-2 499 zł	10%
2 500-3 499 zł	18%
3 500-4 499 zł	17%
4 500-5 299 zł	10%
5 300-7 099 zł	10%
7 100-8 899 zł	2%
8 900-9 999 zł	1%
10 000-14 999 zł	1%
15 000 zł i więcej	1%
I don't know	7%
I would prefer not to answer	12%

About 19% live in centre and another 21% live in broader centre of a city or town (Table 15). These two categories constitutes dummy variable URBAN used later in our econometric models. Then 32% live in village or small town or in remote village or house; these two categories defines dummy variable SUBURBAN. Remaining 28% live in suburbs of a city or town (SUBURB dummy).

Table 15: General population: urban/rural character of area of residence

Centre of a city or town	19%
Broader centre of a city or town	21%
Suburbs of a city or a town	28%
Village or small town rounded by other villages	24%
Remote village or house	8%

7.2 Car purchase

About 71% of respondents form a representative sample of polish population like to buy a passenger car sometimes in the future. This car can be bought by the respondent or any other member of respondent's family. Those who plan to buy a car sometimes in the future, we asked then when they like to do so. About 21% plan to buy a car within a year, 40% plan to buy it within 2 to 3 years. One quarter of respondents plan to buy a car later. Only 8% from the entire sample intend to buy a car later than in 6 years. Less than 16% don't know yet when they like to buy a car.

Nine percent of respondents do not have a car and also do not intend to buy a car in future, whereas 5% don't have a car now but like to have a car later. Less than one third of our sample have a car now but do not plan to buy a car later. Major part of our respondents has a car and would like to buy another car later. Fifteen percent respondents intend the car they plan to buy will serve as an additional one, while 73% plan to buy a car in the future to replace the car they already have (12% don't know it yet).

Figure 8: General population: Percentages of households who intend to buy a car according to expected time of purchase

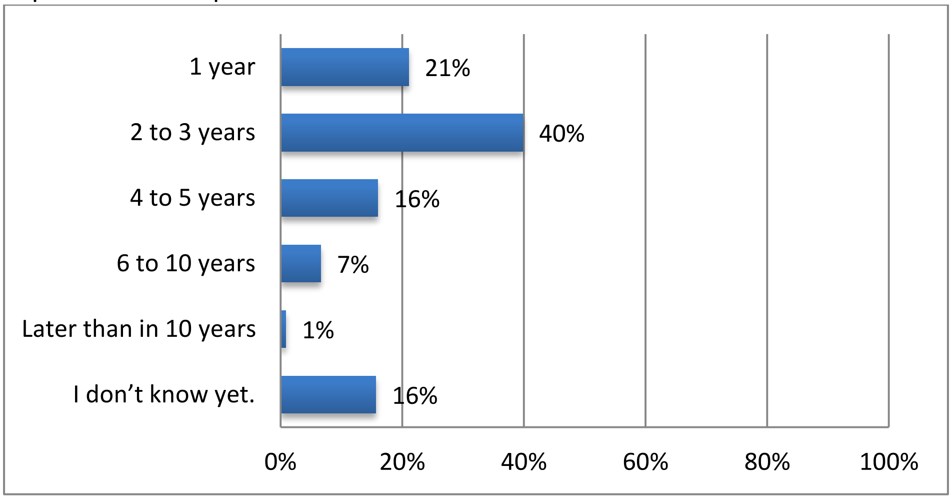
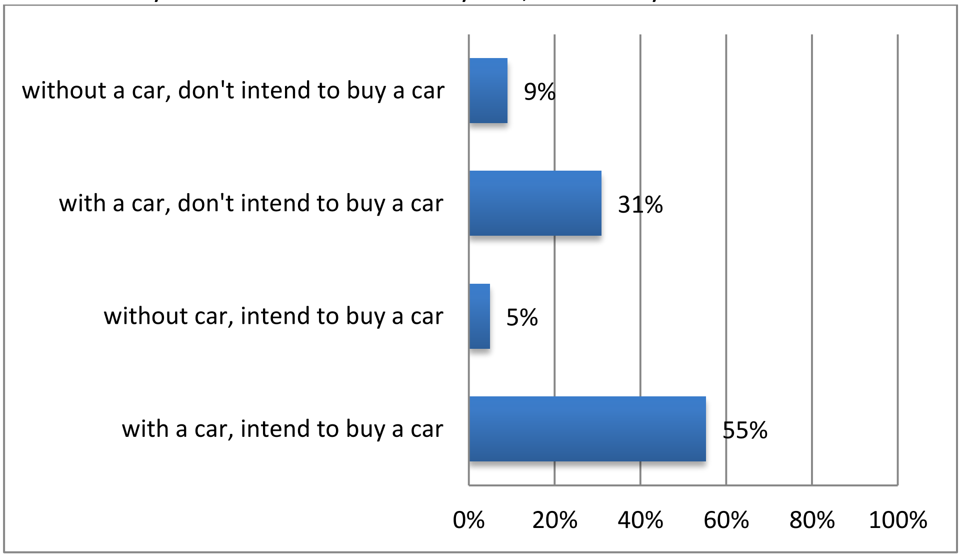


Figure 9: General population: Percentages of households with or without a car that intend or don't intend to buy a car within the next 10 years, our survey



Let us now focus on characteristics of a car that our respondents intend to buy (see Table 16). Our survey has confirmed general knowledge on Polish car market that the most passenger cars have been purchasing a used car. Indeed, two thirds of our respondents (66%) plan to buy a second-hand car, whereas only 14% plan to buy a new car. Remaining 20% don't know yet whether their next car should be new or rather second-hand car. The share of new car buyers is much larger in the pooled data is due to our sampling construct. We explicitly set an even quota on used car segment vs. new car and undecided segment in the sample A (persons who intend to buy a car within next three years).

Same table reports the shares of technologies that the intended car should be equipped. In the representative sample B, majority considers gasoline (58%), 35% is thinking about diesel car and 32% considered LPG gas fitting or to install fitting after purchase (multiple choice option). Only 3.3% consider electricity as the fuel of their future car; 1.8% thought about hybrid car, 1.4% about plug-in hybrid, and the share of electric cars is negligible (0.2%).

Table 16: Characteristics of a car that respondents plan to buy (N=511)

		Pooled sample A+B	**Sample B**
Are you going to buy new or used car?	New	22%	14%
	Used	54%	66%
	I don't know yet	23%	20%
What kind of fuel or alternative technology the car you plan to buy should use?	Gasoline	66%	58%
	Diesel	40%	35%
	Natural gas (CNG)	9%	8%
	With LPG gas fittings / I am going to install fittings after purchase	35%	32%
	Biofuels	2%	1%
	Electricity (electric or hybrid car)	4%	3%
	Other	1%	0.4%
What alternative fuel vehicle do you plan to buy? (percentage from the entire sample)	Electric car	0.3%	0.2%
	Hybrid car	2.1%	1.8%
	Plug-in hybrid car	1.9%	1.4%

Mean purchasing price of a new car that is planned is about 70 336 zł (median=55 000 zł), while the mean price of second-hand car is only one third of the new car price (21 587 zł, median=17 500 zł). Those who are not decided yet whether their future car should be new or used expect the price about 37 600 zł on average (Table 17).

Table 17: Expected purchase price of a future car

	What kind of fuel or alternative technology the car you plan to buy should use?		
Expected purchase price (zł)	**New car**	**Used car**	**I don't know yet**
mean	70 336	21 587	37 615
median	55 000	17 500	35 000

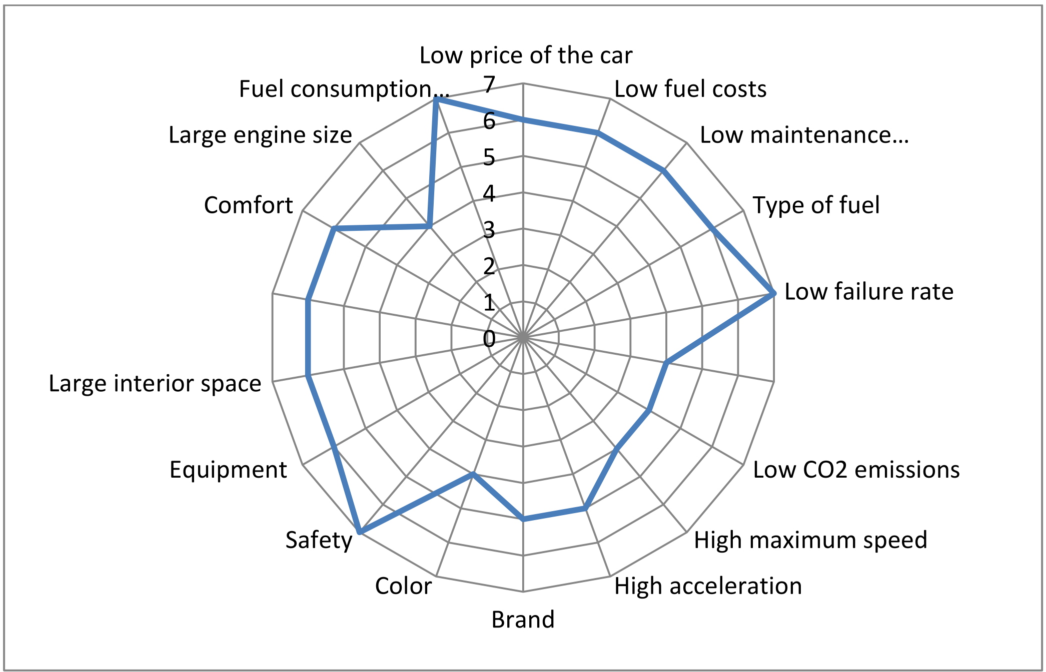
Small family size car (for instance, Skoda Octavia, VW Golf, Honda Civic or Ford Focus) is preferable most by Polish respondents (33%), followed by small cars (e.g., Ford Fiesta, Opel Corsa, Peugeot 208) and large size car (e.g., Audi A4, Ford Mondeo, VW Passat) with 18% and 17% shares. Remaining one third of respondents prefer another car sizes. An executive or luxury cars – most of the hybrid cars – plan to buy 4% respondents only. About 6% is thinking to buy SUV and 7% plan to buy VAN or multi-purpose vehicle (Table 18).

Table 18: Intended car size and class of future car

Categories of cars	**Examples**	**Sample A**	**Sample B**
A class – mini car	*(Fiat Panda or 500, Ford KA, Mitsubishi i-MiEV, Smart Fortwo, Toyota Aygo)*	3.4%	5.7%
B class – small car	*(Ford Fiesta, Kia Rio, Opel Corsa, Peugeot 208, Toyota Yaris, Volkswagen Polo)*	15.2%	17.8%
C class – medium car (small family size)	*(Ford Focus, Honda Civic, Mazda3, Skoda Octavia, Toyota Corolla, Volkswagen Golf)*	28.9%	32.6%
D class – large car (larger family size)	*(Alfa Romeo 159, Audi A4, BMW 3 Series, Ford Mondeo, Mercedes-Benz C-Class, Volkswagen Passat)*	15.1%	17.0%
E class – executive car	*(BMW 5, Chrysler 300, Ford Taurus, Hyundai Grandeur, Lexus GS, Mercedes E, Toyota Avalon, Volvo S80)*	2.6%	2.9%
F/G class – luxury car	*(Audi A8, BMW 7 Series, Lexus LS, Maserati Quattroporte, Mercedes S, Porsche Panamera, Tesla Model S, Toyota Lexus)*	0.5%	1.4%
S class – sport coupe or convertible	*(Audi TT, BMW Z4, BMW 6, Chevrolet Camaro, Ferrari FF, Jaguar XK, Lamborghini, Maserati GranTurismo, Mazda MX-5, Mercedes CLK, Volvo C70)*	0.6%	1.2%
SUV – small off-road	*(Ford Ecosport / Escape, Honda CR-V, Jeep Liberty, Kia Sportage, Mitsubishi Pajero iO, Suzuki Jimny)*	3.8%	4.5%
SUV – large off-road	*(Ford Edge, Ford Explorer, Range Rover, Jeep Grand Cherokee, Toyota Land Cruiser, Volkswagen Touareg, Volvo XC90,)*	1.7%	1.8%
VAN, Multi-purpose vehicle – small	*(Citroen C3 Picasso, Ford B-Max or C-Max, Opel Meriva, Renault Modus or Scenic, Opel Zafira, Renault Kangoo, VW Touran)*	3.5%	4.3%
VAN, Multi-purpose vehicle – large	*(Ford Galaxy / Transit Connect / Ford E350 Van, Peugeot 807, Renault Espace, SEAT Alhambra)*	1.9%	2.5%
Pickup – small pick-up	*(Chevrolet Montana / Colorado, Fiat Strada / Ranger, Volkswagen Saveiro, Mitsubishi Triton/L200, Nissan Navara)*	0.1%	0.6%
Pickup – standard pick-up	*(Dodge Ram, Ford F-150, GMC Sierra, Nissan Titan, Toyota Tundra)*	0.1%	0.4%
Other		2.6%	2.0%

Using 7-point Lickert scale, we then asked how important are characteristics of a car when you are going to purchase a car. Figure 10 displays the results for the representative sample. Fuel consumption, low failure rate and car safety are considered the most important. Engine size, extended car warranty, high maximum speed, colour, but also low CO2 emissions are rated as least important car characteristics. Purchase price, fuel costs and maintenance costs are rated same by 6 points, but still less than the fuel efficiency and car safety (see Figure 10).

Figure 10: Importance of characteristics of purchased car

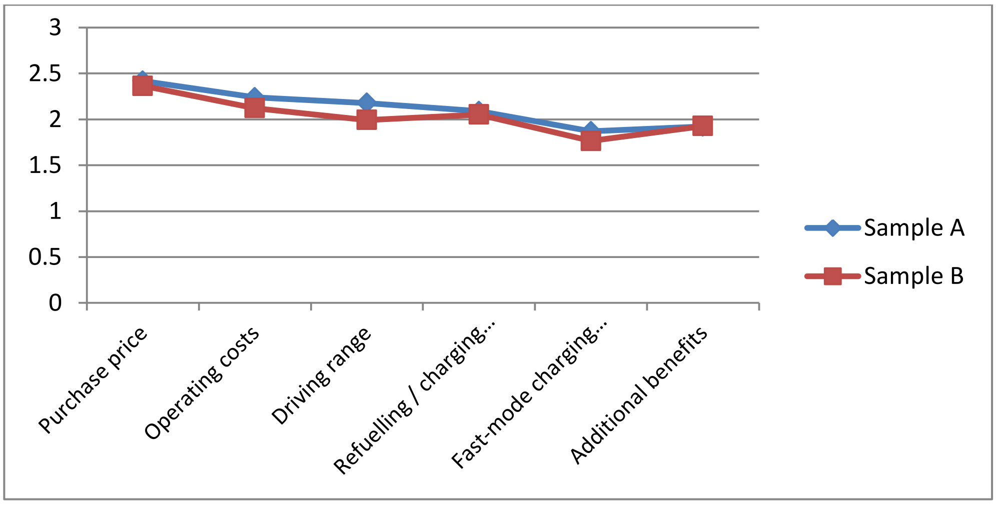


Note: 1 is not important at all and 7 is very important characteristic.

7.3 Debriefing – comprehension of the choice experiment

Comprehension of the choice experiment to elicit preferences for passenger cars and their attributes does not differ significantly between the general population sample and among people who would like to buy a car. Comprehension was measured by Likert scale in which -3 meant difficult to understand and +3 easy to understand. On average, people perceived all the characteristics as rather easy to understand (the mean ranged from 1.8 to 2.4) (see Figure 11).

Figure 11: Comprehension of the choice experiment “Which characteristics of the options were difficult or easy for you to understand?”



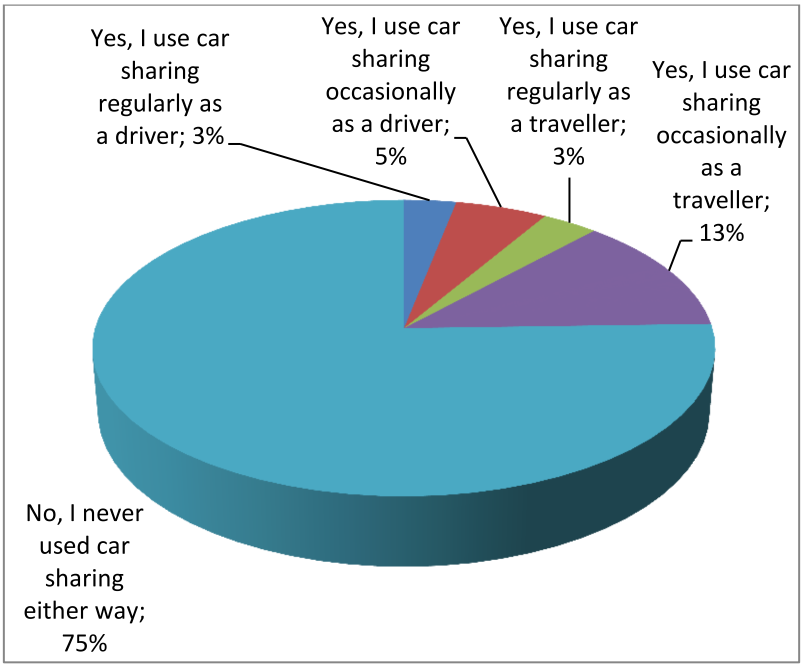
8 Results

8.1 Willingness to participate in car-sharing systems

Real and hypothetical usage of two new business models – car-pooling and car-sharing is examined in this subchapter. Car-pooling means that people who plan to drive by their car would offer a seat to others who will contribute the driver to cover fuel and operational costs. Taxi is not considered as car-pooling. Car-pooling is also different from a scheme in that a group of people can – following certain conditions – share cars from a fleet that is common. Car-sharing presents a scheme in that a group of people can share and use cars from a fleet that is common to each member who belong to the group.

Specifically, we examine knowledge, usage and stated preference for the two systems. We find that 25% of Polish have already heard about car-pooling and 27% have heard about car-sharing. However, only 8% used car-pooling as driver and 16% as a traveller (Figure 12). About 11% have participated in a car-sharing system and only 2% are members of some car-sharing system.

Figure 12. Have you ever used car-pooling?



In next part of the questionnaire, respondents were asked to imagine that there is an opportunity to use car-sharing in your town, even if it is not possible now. Two car-pooling systems were briefly described to respondents. First, there would be a conventional cars using either diesel or petrol of various sizes in the car pool, while in the second there would be electric cars – both hybrid and plug-in – of various sizes in the pool. The order of these systems varied at random.

Respondents were then asked to decide whether they would participate in these systems under given conditions, using single-bounded discrete choice question. One of the conditions was price of the service, specifically price per km driven and an additional fee per hour for using a car. The additional fee per hour was used in one of the two split samples only, assigned to our respondents at random. We use four values of price per km (20 groszy, 40 groszy, 60 groszy, and 1 zloty) and four values of fees per hour when a car was shared (2, 3, 5, and 15 zl per hour). One of these values were assigned to each respondent and each of the two car-pooling systems (either having CVs or HV+PHEV) randomly.

On average, about 19% would participate in the car-sharing system and this share declines with the price per kilometre offered. If our respondents were asked to pay additional costs per hour, the share decline to 12%. The shares of respondents who would participate in the hypothetical car-sharing system increased, when we suggested that only EVs would be included in the vehicle fleet, at 22% and 13.5% respectively. Median mileage per month of this car lies in interval 100 km to 200 km and the mean mileage is about 187 km a month (excluding those who don't know).

Table 19: How many kilometres would you drive by a car from the pool per a month

	car-pooling with CVs	car-pooling with HVs and PHEVs
Less than 10 km	3.7%	3.9%
10 km to 20 km	5.2%	3.9%
20 km to 50 km	14.8%	8.5%
50 km to 100 km	14.1%	16.3%
100 km to 200 km	14.1%	19.6%
200 km to 300 km	14.1%	10.5%
300 km to 400 km	5.2%	6.5%
more than 400 km	12.6%	11.1%
more than 200 km (used in pilot)	3.0%	0.7%
I don't know / hard to say	13.3%	19.0%

More than 53% of them think it is quite unlikely they would be using a car from the car-pooling a scheme if such system was introduced in near future in the region where they live (first three levels on 7-point Lickert scale), while 23% rather think it is quite likely they would be using the car-pooling (last three points on the scale).

Using non-parametric Turnbul estimator, lower bound of mean willingness-to-pay for using a car from the car-pooling scheme was estimated at 18 groszy per km for CV and 16 groszy per km for EV. Mean WTP estimated parametrically is 43 groszy.

Willingness to pay for using a car from a car-pooling system is positive, although the mean value is smaller than actual market price of recently operating systems in Poland. Providing subsidy to such systems might involve other effects. For instance, we found in our survey that 6.2% of respondents who intend to buy a car sometimes in future would also not definitely buy this car if such car-pooling system was operating and the region they live (Table 20). Additional 18.6% would not probably buy it. About 56% who stated that they are not planning to buy a car also stated later that they might buy it (under a scenario of car-pooling system in operation). The existence of car-pooling system would still support 44% of them to keep their positions on not buying a car.

Table 20: Would you like to buy an own private car, if such car-pooling system was introduced in the region where you live

	intend to buy a car sometimes in future	do not intend to buy a car
Definitely yes	26.6%	16.1%

Probably yes	48.6%	40.4%
Probably not	18.6%	26.5%
Definitely not	6.2%	17.0%

8.2 Modelling consumer preferences for electricity driven vehicles

In this subchapter, we present the results of respondents' preference modelling, based on the discrete choice experiments. The results include only respondents sampled from general population who declared that they intend to buy a new car. In order to get more robust estimates we then pool data from both samples (general population and respondents who agreed at the beginning of the survey to intend to buy a car within next 3 years). These results are presented in Appendix 1.

Speeders (i.e. respondents who spent relatively short time to fill the questionnaire) are excluded from analyzed data. It resulted in total of 489 respondents in sample of general population, giving us 3,912 observations (8 responses from each respondent). Sample with pooled data from both samples includes 18,168 observations from 2,271 respondents and excluding speeders give us in total 17,248 observations from 2,156 respondents. Including data from the pilot test or excluding speeders would not change the results much (see Table 38 in Appendix 1 for the results when speeders or data from the pilot are excluded).

Table 21 presents a general overview of respondents' preferences. The first panel presents the results of a simple multinomial logit model (MNL), the second gives the results of a mixed logit model (MXL) which is superior in being able to take the respondents' unobserved heterogeneity into account (i.e., it does not assume that every respondent has exactly the same preferences, but instead models respondents' preferences as normal distributions – and hence provides an estimate of the mean and standard deviation of the distribution of parameters for each attribute).

The first three parameters represent alternative specific constants associated with one of the alternative fuel technologies: HV – hybrid, PV – plug-in hybrid, and EV – electric vehicles. Since all the coefficients are negative we conclude that respondents are, in general, reluctant to choose alternative fuelled cars and prefer a conventional car (reference). The relative values of the coefficients indicate, that respondents are more likely to buy hybrid plugin cars, then hybrid, and consider electric vehicles as the most (unfavourably) different to conventional fuelled ones. We note, however, that there is considerable preference heterogeneity with respect to these parameters, as indicated by relatively large standard deviations – even though the estimates of the means are negative, a substantial share of the population would have positive preferences for the alternative fuel vehicles.

The next set of parameters describes respondents' preferences for the purchase price (PP, in 10,000 PLN), operating and fuel cost (OC, in 100 of PLN per month), driving range (DR, in 100 km) and recharge/refuel time (RT, in hours). The purchase price (in 10,000 PLN) is naturally negative since higher costs are associated with negative utility. Similarly, higher operating and fuel costs and recharge time make respondents' worse off. Larger driving range, on the other hand is, as expected, preferred. All this parameters are statistically significant.

The next set of parameters describes additional perks included in the experiment to see if there are easily achievable policies which could make respondents more likely to buy alternative fuel cars. We found that offering free public transport (FT) and free parking (FP) were to a large extent insignificant, although considerable preference heterogeneity indicates that there are some respondents for whom the attributes are highly demanded.

Finally, the last two attributes represent the influence of the availability of fast-charge infrastructure (medium availability – INFR2 or high availability – INFR3, vs. low availability – the reference) for choosing a particular alternatives. We only observe a significant effect for high availability of this kind of infrastructure, potentially indicating high non-linearities in respondents’ preferences (only high enough level of charging infrastructure is perceived by respondents as beneficial).

Table 21. Estimation results – basic model

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-0.8069*** (0.0593)	-1.3769*** (0.1760)	2.2669*** (0.1640)
PV	-0.7015*** (0.0719)	-1.1513*** (0.1734)	2.1792*** (0.1529)
EV	-0.6490*** (0.1239)	-2.8017*** (0.2962)	3.1392*** (0.2119)
PP	-0.4388*** (0.0291)	-1.3103*** (0.0839)	1.0240*** (0.1019)
OC	-1.0836*** (0.1551)	-4.0224*** (0.4468)	1.4732*** (0.5457)
DR	0.1144*** (0.0118)	0.1881*** (0.0193)	0.1058*** (0.0367)
RT	-0.0311** (0.0147)	-0.1066*** (0.0331)	0.2568*** (0.0406)
FT	0.1195*** (0.0412)	0.1048 (0.0809)	0.6350*** (0.1166)
FP	0.1837*** (0.0411)	0.2675*** (0.0761)	0.6057*** (0.1288)
INFR2	0.3169*** (0.0694)	0.6517*** (0.1093)	0.0003 (0.3889)
INFR3	0.6082*** (0.0665)	1.1472*** (0.1105)	0.6111*** (0.1675)
Model characteristics			
Log-likelihood (constants only)	-5273.54	-5273.54	
Log-likelihood	-5032.09	-3895.54	
McFadden's pseudo-R^2	0.05	0.26	
AIC/n	2.58	2.00	
n (observations)	3912.00	3912.00	
k (parameters)	11.00	22.00	

To make it easier to interpret our results, we also present the same models estimated in monetary-space – i.e., all utility function parameters were represented in relation to the (negative) purchase price coefficient. This allows for interpreting parameters in Table 22 as if they were marginal rates of substitution of each attribute for the purchase price, i.e. the trade-off that makes respondents indifferent – how much more they would have to pay for a car to get each of the attributes to have the same utility level (this is analogue to the willingness to pay measure).

Table 22: Estimation results – basic model in WTP-space

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-1.8387*** (0.1817)	-1.2998*** (0.1316)	2.2540*** (0.1657)
PV	-1.5985*** (0.1914)	-1.1996*** (0.1009)	1.9881*** (0.1208)
EV	-1.4788***	-2.8692***	2.8796***

	(0.3003)	(0.2645)	(0.1679)
OC	-2.4692*** (0.3840)	-3.5978*** (0.3752)	1.6698*** (0.1627)
DR	0.2607*** (0.0309)	0.1258*** (0.0194)	0.1076*** (0.0140)
RT	-0.0708** (0.0334)	-0.0520** (0.0204)	0.1549*** (0.0182)
FT	0.2723*** (0.0951)	0.0748 (0.0547)	0.2469*** (0.0943)
FP	0.4186*** (0.0967)	0.2850*** (0.0548)	0.0802 (0.0712)
INFR2	0.7221*** (0.1625)	0.4649*** (0.0835)	0.4678*** (0.0811)
INFR3	1.3860*** (0.1645)	0.8817*** (0.0864)	0.5406*** (0.1466)
PP	0.4388*** (0.0291)	0.2098*** (0.0798)	1.1516*** (0.1035)
Model characteristics			
Log-likelihood (constants only)	-5273.54	-5273.54	
Log-likelihood	-5032.09	-3918.69	
McFadden's pseudo-R^2	0.05	0.26	
AIC/n	2.58	2.01	
n (observations)	3912.00	3912.00	
k (parameters)	11.00	22.00	

The results provided in Table 22 allow for convenient interpretation but are otherwise equivalent of those presented in Table 21. To provide an example – the coefficient of -1.2998 for the mean preferences for *HV* means, that purchasing a hybrid vehicle would be an equivalent of purchasing a conventional vehicle but having had to pay 12,998 PLN more (on average for entire sample). The same interpretation can be used for all the other coefficients. We note that PP is expressed in 10,000 PLN, so each value should be multiplied by 10,000 to get money equivalent in PLN. Operation cost and driving range are measured in PLN per 100 km or in 100 km, so one needs additionally to divide the values by 100 to get WTP per unit; WTP for OC is estimated at 360 PLN per 1 PLN of OC per km and WTP for DR is 12.6 PLN per additional km driving range. WTP for additional benefits are 748 PLN for free public transport and 2,850 PLN for free parking, however the coefficient of the former is not statistically significant. WTP for fast-mode recharging infrastructure is 4,649 PLN (medium) and 8,817 PLN (high). The last coefficient (PP) presents the non-normalized value for the underlying normal distribution of the lognormally distributed purchase price in preference space and as such does not have a direct interpretation.

We next consider the possibility that respondents' preferences for all choice attributes are alternative-specific. Table 23 presents the results in which all attributes were interacted with alternative specific constants for alternative fuel technologies. The results show that in some cases respondents are indeed more or less sensitive to some attributes when purchasing a particular type of car. For example, respondents appear to be less sensitive to the purchase price of hybrid vehicles (as indicated by a positive and significant interaction PP*HV) in the MNL model – these result goes away, however, once preference heterogeneity is accounted for. Most of the interaction effects in the MXL model are in fact insignificant – showing that the attributes are fairly generic and preferences for them do not depend on the kind of the car respondents were thinking of purchasing – with one exception: when considering electric vehicles, respondents were much (three times) more sensitive to the driving range, and somewhat more sensitive to high availability of fast-charge infrastructure. These results are understandable, considering that electric vehicles have, on average, lower range.

Table 23: Estimation results – model with alternative specific attributes, preference-space

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-1.8595*** (0.2970)	-0.8899 (0.5770)	1.3082*** (0.2824)
PV	-1.1730*** (0.2846)	-1.7030*** (0.5927)	1.6799*** (0.2314)
EV	-0.9328*** (0.2488)	-4.1261*** (0.7379)	3.0771*** (0.3049)
PP	-0.4668*** (0.0318)	-1.3875*** (0.1005)	1.2319*** (0.1255)
PP*HV	0.0903*** (0.0170)	-0.0169 (0.0512)	0.2043*** (0.0531)
PP*PV	0.0203 (0.0160)	-0.0489 (0.0455)	0.1426*** (0.0449)
PP*EV	-0.0306 (0.0168)	-0.1178 (0.0805)	0.3062*** (0.0688)
OC	-1.7283*** (0.2634)	-5.3359*** (0.5893)	1.1320** (0.5607)
OC*HV	0.4819*** (0.1503)	0.1235 (0.4421)	0.8914*** (0.2750)
OC*PV	0.2506 (0.1393)	0.4645 (0.4222)	1.1794*** (0.2858)
OC*EV	-0.7840** (0.3117)	-0.5743 (1.0723)	5.4000*** (0.7995)
DR	0.0795*** (0.0208)	0.1496*** (0.0366)	0.1174*** (0.0422)
DR*HV	0.0439 (0.0325)	-0.0848 (0.0629)	0.2043*** (0.0352)
DR*PV	0.0260 (0.0307)	0.0296 (0.0529)	0.1857*** (0.0331)
DR*EV	0.1024*** (0.0352)	0.3188*** (0.0699)	0.0681 (0.0948)
RT	-0.0020 (0.0378)	-0.0524 (0.0655)	0.1941*** (0.0501)
RT*EV	-0.0425 (0.0454)	-0.1130 (0.0857)	0.3385*** (0.0622)
FT	0.1509 (0.0924)	0.2521 (0.1588)	0.6348*** (0.1215)
FT*PV	-0.0666 (0.1297)	-0.0666 (0.2265)	0.0617 (0.3839)
FT*EV	0.0010 (0.1277)	-0.2678 (0.2598)	0.9495*** (0.3018)
FP	0.2157** (0.0918)	0.3042** (0.1482)	0.7260*** (0.1303)
FP*PV	0.1185 (0.1251)	0.1862 (0.2045)	0.0434 (0.4503)

FP*EV	-0.1949 (0.1302)	-0.2358 (0.2427)	0.0835 (0.4727)
INFR2	0.3217*** (0.0991)	0.6894*** (0.1658)	0.0000 (0.2894)
INFR2*EV	-0.0133 (0.1403)	-0.0996 (0.2970)	1.0754*** (0.3675)
INFR3	0.4410*** (0.0963)	1.0194*** (0.1681)	0.8136*** (0.1898)
INFR3*EV	0.3700*** (0.1375)	0.7165*** (0.2761)	1.2464*** (0.3635)
Model characteristics			
Log-likelihood (constants only)	-5273.54	-5273.54	
Log-likelihood	-4994.32	-3838.28	
McFadden's pseudo-R^2	0.05	0.27	
AIC/n	2.57	1.99	
n (observations)	3912.00	3912.00	
k (parameters)	27.00	54.00	

We now turn to investigating how the preferences of our respondents' differed with respect to their socio-demographic characteristics as well as with respect to the type of car they intended to buy. Table 24, 25 and 26 present the results of the models estimated for respondents who intended to buy a new or used car, or were still undecided, respectively.

By inspecting relative values (absolute values of coefficients are not comparable between different models) we find that respondents who intend to buy a used car about half less generally opposed to purchasing alternative fuel vehicles (relative to the purchase price). They are also less sensitive to operating cost and much less sensitive to recharging time. On the other hand, respondents who intend to buy new cars are much more interested in accompanying bonus policies, such as free parking or public transport, as well as to the availability of fast-mode charging infrastructure. The results also make it possible to establish whether the respondents who are undecided whether they want to buy a new or used car are more similar to one or the other category, with respect to each of the attributes.

Table 24: Estimation results – new car segment, WTP-space

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-0.8590*** (0.1257)	-1.8021*** (0.4508)	2.7663*** (0.5153)
PV	-0.5811*** (0.1496)	-1.4077*** (0.4022)	2.4778*** (0.3837)
EV	-0.7104*** (0.2657)	-3.0534*** (0.8028)	3.7707*** (0.5438)
PP	-0.3016*** (0.0370)	-1.0233*** (0.1380)	0.9077*** (0.1417)
OC	-1.2825*** (0.3869)	-4.2054*** (1.2326)	0.1647 (2.0700)
DR	0.0975*** (0.0247)	0.1652*** (0.0506)	0.0000 (0.1140)
RT	-0.0353 (0.0312)	-0.1784** (0.0899)	0.3354*** (0.1037)
FT	0.0797 (0.0876)	0.1212 (0.2545)	0.8041** (0.3451)
FP	0.2099** (0.0874)	0.3257 (0.2178)	0.5482 (0.3659)
INFR2	0.1355 (0.1468)	0.5843 (0.4059)	0.6766 (0.6666)
INFR3	0.4667*** (0.1408)	1.2376*** (0.2848)	0.0552 (0.6315)
Model characteristics			
Log-likelihood (constants only)	-1179.97	-1179.97	
Log-likelihood	-1123.40	-813.64	
McFadden's pseudo-R^2	0.05	0.31	
AIC/n	2.58	1.90	
n (observations)	880.00	880.00	
k (parameters)	11.00	22.00	

Table 25: Estimation results – used car segment, WTP-space

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-0.8813*** (0.0838)	-1.4485*** (0.2654)	2.4727*** (0.2883)
PV	-0.8238*** (0.1022)	-1.2571*** (0.2518)	2.3698*** (0.2245)
EV	-0.5571*** (0.1720)	-2.4655*** (0.4273)	2.9553*** (0.2908)
PP	-0.5919*** (0.0710)	-1.6407*** (0.1896)	1.5792*** (0.2491)
OC	-0.8188*** (0.1995)	-3.4320*** (0.6284)	0.4621 (0.9599)
DR	0.1284*** (0.0165)	0.2199*** (0.0285)	0.1472*** (0.0515)
RT	-0.0280 (0.0205)	-0.0806 (0.0422)	0.2757*** (0.0587)
FT	0.1146** (0.0582)	0.1064 (0.1123)	0.4985*** (0.1736)
FP	0.1426** (0.0579)	0.1343 (0.1147)	0.7411*** (0.1634)
INFR2	0.4268*** (0.0968)	0.7594*** (0.1527)	0.0001 (0.4997)
INFR3	0.6296*** (0.0934)	1.1624*** (0.1437)	0.2504 (0.3692)
Model characteristics			
Log-likelihood (constants only)	-2697.74	-2697.74	
Log-likelihood	-2598.99	-2055.00	
McFadden’s pseudo-R^2	0.04	0.24	
AIC/n	2.59	2.06	
n (observations)	2016.00	2016.00	
k (parameters)	11.00	22.00	

Table 26: Estimation results – segment of undecided, WTP-space

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-0.5783*** (0.1146)	-1.0568*** (0.2916)	1.8552*** (0.2777)
PV	-0.5724*** (0.1411)	-1.1406*** (0.3518)	1.9175*** (0.3143)
EV	-0.8375*** (0.2536)	-3.6280*** (0.6516)	4.3199*** (0.6928)
PP	-0.6237*** (0.0581)	-1.5527*** (0.1940)	1.2015*** (0.1776)
OC	-1.8185*** (0.3652)	-5.2975*** (0.9980)	1.9329 (1.1562)
DR	0.1088*** (0.0229)	0.1609*** (0.0454)	0.1482** (0.0706)
RT	-0.0408 (0.0283)	-0.1149 (0.0654)	0.1588 (0.1149)
FT	0.1590** (0.0789)	0.1751 (0.2043)	1.0736*** (0.2232)
FP	0.2463*** (0.0790)	0.5506*** (0.1553)	0.3135 (0.3541)
INFR2	0.2896** (0.1391)	0.4333 (0.2910)	0.8254** (0.3893)
INFR3	0.7614*** (0.1315)	1.4861*** (0.2641)	1.1847*** (0.3480)
Model characteristics			
Log-likelihood (constants only)	-1389.12	-1389.12	
Log-likelihood	-1282.27	-987.47	
McFadden's pseudo-R^2	0.08	0.29	
AIC/n	2.55	1.99	
n (observations)	1016.00	1016.00	
k (parameters)	11.00	22.00	

In the following analysis of the influence of respondents' socio-demographic and attitudinal characteristics on their car choice preferences we allow for the purchase price and operating cost to be fuel-specific. To establish a baseline, Table 27 presents the results of such a model. Even though most of these interactions are not significant, we do not want to rule out that they will be significant once respondents' socio-demographic characteristics are taken into account.

Table 27: Estimation results – price and costs alternative specific, preference-space

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-1.5018*** (0.1626)	-1.1481** (0.4515)	1.8823*** (0.2426)
PV	-0.9429*** (0.1534)	-1.6861*** (0.4081)	1.6351*** (0.2196)
EV	-0.5156*** (0.1704)	-3.8148*** (0.5606)	3.4226*** (0.2648)
PP	-0.4619*** (0.0311)	-1.3617*** (0.0987)	1.1150*** (0.1098)
PP*HV	0.0901*** (0.0170)	-0.0320 (0.0551)	0.2518*** (0.0513)
PP*PV	0.0189 (0.0160)	-0.0567 (0.0483)	0.2248*** (0.0446)
PP*EV	-0.0290 (0.0167)	0.0398 (0.0596)	0.1885*** (0.0676)
OC	-1.6648*** (0.2605)	-4.9399*** (0.5162)	0.0000 (0.7190)
OC*HV	0.4644*** (0.1502)	-0.0554 (0.4702)	1.1188*** (0.3297)
OC*PV	0.2442 (0.1391)	0.8442** (0.3925)	1.2994*** (0.2843)
OC*EV	-0.6871** (0.3080)	1.1137 (0.8798)	2.6648*** (0.9327)
DR	0.1152*** (0.0118)	0.1906*** (0.0195)	0.0966** (0.0409)
RT	-0.0376** (0.0148)	-0.0923*** (0.0324)	0.2440*** (0.0412)
FT	0.1196*** (0.0412)	0.1254 (0.0860)	0.6808*** (0.1154)
FP	0.1773*** (0.0413)	0.2661*** (0.0806)	0.6556*** (0.1232)
INFR2	0.3263*** (0.0696)	0.6369*** (0.1227)	0.4018 (0.2468)
INFR3	0.6266*** (0.0667)	1.2038*** (0.1093)	0.5584*** (0.1853)
Model characteristics			
Log-likelihood (constants only)	-5273.54	-5273.54	
Log-likelihood	-5007.12	-3877.57	
McFadden’s pseudo-R^2	0.05	0.26	
AIC/n	2.57	2.00	
n (observations)	3912.00	3912.00	
k (parameters)	17.00	34.00	

Tables 28 – 29 present the results of the models for respondents’ with low, medium and high level of education, respectively. The comparisons can be made just as in the case of Tables 24 – 26, using the ratios of the estimated coefficients. Similarly, Tables 30 – 31 give the results for respondents who declared to be living in urban, sub-urban and rural neighborhoods.

Next two model, Table 32 and 33, report the estimation results when the vehicle attributes are interacted with income and dummy variable equal to one if there is ate last one child in a family. Variables with “NaN” ending denotes dummy variable equal to one if respondent did not provided information on income, or occurrence of child, respectively. We find that richer people are more in favor of hybrid cars and less favor in electric cars (those who did not provided income information are even less favor in EV). They are also less sensitive on operational and fuel costs. Families with children are then less favor of hybrid and plug-in hybrid vehicles and do not prefer higher purchasing price and medium level of fast-mode recharging infrastructure availability compared to childless families. Respondents who did not provided information about their children have the lowest preference for purchasing price.

Tables 34 and 35 displays the results for engine size (what an engine size your new car should most likely have, measured in cm3) and mileage (stated average kilometers per year a respondent and her family expect to drive by a car she intends to buy). With respect to engine size, we find different preferences only for EV and DR; respondents planning to buy a car with greater engine are less likely to buy EV but would prefer their car can drive more kilometers on after full tank or recharging car batteries.

Table 28: Estimation results – MNL for low medium and high level of education, preference-space

	Low education	Medium education	High education
	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)
HV	-1.0522 (0.6031)	-0.5671*** (0.1386)	-1.8040*** (0.2048)
PV	-1.9392*** (0.5901)	-0.0940 (0.1360)	-1.2790*** (0.1916)
EV	1.3532** (0.6026)	0.5080*** (0.1476)	-1.2040*** (0.2181)
PP	-0.2220 (0.1486)	-0.3674*** (0.0286)	-0.4702*** (0.0361)
PP*HV	0.0663 (0.0887)	-0.0190 (0.0152)	0.1144*** (0.0193)
PP*PV	0.0949 (0.0840)	-0.0092 (0.0131)	0.0281 (0.0184)
PP*EV	-0.1068 (0.0778)	-0.0532*** (0.0134)	0.0107 (0.0195)
OC	-0.8264 (0.8618)	-0.7732*** (0.2349)	-2.3044*** (0.3340)
OC*HV	0.4648 (0.5372)	-0.1390 (0.1291)	0.7143*** (0.2007)
OC*PV	1.1825** (0.4751)	-0.5529*** (0.1281)	0.6142*** (0.1820)
OC*EV	-1.9066 (1.0632)	-1.3746*** (0.2690)	-0.4158 (0.4002)
DR	0.1432*** (0.0442)	0.1050*** (0.0111)	0.1179*** (0.0144)
RT	-0.0064 (0.0500)	-0.0410*** (0.0136)	-0.0329 (0.0186)
FT	0.2332 (0.1412)	0.0494 (0.0392)	0.1276** (0.0509)
FP	-0.0184 (0.1408)	0.1304*** (0.0389)	0.2382*** (0.0510)
INFR2	0.1705 (0.2392)	0.3202*** (0.0633)	0.2697*** (0.0865)
INFR3	0.6436*** (0.2280)	0.4036*** (0.0614)	0.6302*** (0.0821)
Model characteristics			
Log-likelihood (constants only)			
Log-likelihood	-400.92	-5749.85	-3326.34
McFadden's pseudo-R^2	0.05	0.04	0.06
AIC/n	2.62	2.60	2.55
n (observations)	320.00	4440.00	2624.00
k (parameters)	17.00	17.00	17.00

Table 29: Estimation results – MXL for low medium and high level of education, preference-space

	Low education		Medium education		High education	
	Mean (s.e.)	Standard deviation (s.e.)	Mean (s.e.)	Standard deviation (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-3.3532 (6.6353)	2.7082 (2.2181)	-0.4117 (1.2382)	1.4670** (0.5787)	-1.4585** (0.6065)	1.9862*** (0.2511)
PV	-4.0477 (4.7209)	1.2629 (2.5876)	-0.2125 (1.1311)	2.8202*** (0.5688)	-1.9955*** (0.5282)	1.6424*** (0.2593)
EV	-0.8471 (10.0933)	3.5251 (3.8009)	-2.0050 (1.1474)	3.1463*** (0.5422)	-4.1085*** (0.6921)	3.0509*** (0.3373)
PP	-0.4077 (2.2026)	1.5099 (1.7969)	-1.4452*** (0.2612)	0.8597*** (0.3185)	-1.5593*** (0.1306)	1.2575*** (0.1271)
PP*HV	-0.0169 (1.2489)	0.1724 (1.3825)	0.0392 (0.1920)	0.4145*** (0.1514)	-0.0116 (0.0621)	0.2495*** (0.0578)
PP*PV	-0.3348 (1.1196)	0.8553 (0.9273)	-0.2091 (0.1756)	0.1376 (0.1689)	-0.0744 (0.0539)	0.1942*** (0.0571)
PP*EV	0.1426 (1.4572)	0.0035 (1.8547)	-0.1279 (0.1992)	0.4530*** (0.1517)	0.0171 (0.0740)	0.2040*** (0.0693)
OC	-2.8646 (9.6157)	0.0000 (10.4927)	-2.3717** (1.1702)	0.0000 (1.8243)	-6.3968*** (0.6781)	0.0357 (0.9834)
OC*HV	1.9233 (7.3161)	0.0000 (3.3661)	-1.3135 (1.1774)	1.7406** (0.7117)	0.2504 (0.6350)	0.8781** (0.3633)
OC*PV	3.4809 (3.2140)	1.8697 (3.4864)	-0.9644 (0.9003)	0.0451 (0.7192)	1.4575*** (0.5182)	1.1000*** (0.3936)
OC*EV	0.3813 (7.3754)	1.7681 (8.9147)	0.5170 (1.9385)	1.4377 (2.4539)	0.4619 (1.2452)	4.2807*** (1.1067)
DR	0.1838 (0.2320)	0.0000 (1.3502)	0.2060*** (0.0537)	0.1640** (0.0814)	0.2090*** (0.0256)	0.1345*** (0.0467)
RT	-0.0683 (0.4184)	0.3153 (0.4322)	-0.1128 (0.0705)	0.1340 (0.0956)	-0.1173** (0.0485)	0.3529*** (0.0522)
FT	0.5621 (1.0742)	0.3828 (2.9623)	0.0869 (0.1620)	0.0002 (0.4068)	0.1239 (0.1122)	0.7266*** (0.1434)
FP	-0.1197 (0.7992)	0.0094 (4.7057)	0.0676 (0.1900)	0.8638*** (0.3112)	0.4014*** (0.1047)	0.6481*** (0.1575)
INFR2	0.3055 (1.1611)	0.0000 (9.5908)	1.0450*** (0.2512)	0.0406 (1.2957)	0.5259*** (0.1530)	0.3878 (0.3293)
INFR3	1.4203 (1.4164)	1.3854 (2.4279)	1.3474*** (0.3253)	1.2544*** (0.3535)	1.1571*** (0.1364)	0.3955 (0.2768)
Model characteristics						
Log-likelihood (constants only)						
Log-likelihood	-295.18		-957.27		-2576.71	
McFadden's pseudo-R^2	0.30		0.26		0.27	
AIC/n	2.08		2.05		1.99	
n (observations)	320.00		968.00		2624.00	
k (parameters)	34.00		34.00		34.00	

Table 30: Estimation results – MNL for urban, suburban, rural residence area, preference-space

	Urban	Suburban	Rural
	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)
HV	-1.5571*** (0.2569)	-1.5501*** (0.2918)	-1.5213*** (0.3158)
PV	-0.9804*** (0.2473)	-0.4331 (0.2764)	-1.6939*** (0.2937)
EV	-0.9193*** (0.2814)	-0.0917 (0.3052)	-0.6431** (0.3221)
PP	-0.4690*** (0.0514)	-0.3717*** (0.0523)	-0.6102*** (0.0601)
PP*HV	0.1070*** (0.0280)	0.0846*** (0.0258)	0.0782** (0.0356)
PP*PV	0.0249 (0.0264)	-0.0482 (0.0274)	0.1100*** (0.0308)
PP*EV	-0.0467 (0.0298)	-0.0668** (0.0276)	0.0543 (0.0310)
OC	-2.1355*** (0.4387)	-1.0773** (0.4788)	-1.7916*** (0.4536)
OC*HV	0.5002** (0.2309)	0.3322 (0.2646)	0.6809** (0.3113)
OC*PV	0.1474 (0.2190)	-0.0597 (0.2477)	0.9048*** (0.2786)
OC*EV	-0.7260 (0.5032)	-0.4887 (0.5575)	-0.7024 (0.5757)
DR	0.1310*** (0.0193)	0.1066*** (0.0222)	0.1055*** (0.0203)
RT	-0.0314 (0.0249)	-0.0526 (0.0280)	-0.0352 (0.0250)
FT	0.1724** (0.0681)	0.1266 (0.0783)	0.0596 (0.0700)
FP	0.1737** (0.0680)	0.1625** (0.0781)	0.1940*** (0.0704)
INFR2	0.4722*** (0.1167)	0.2620** (0.1284)	0.2467** (0.1202)
INFR3	0.7899*** (0.1124)	0.4610*** (0.1254)	0.6171*** (0.1125)
Model characteristics			
Log-likelihood (constants only)			
Log-likelihood	-1864.73	-1419.30	-1691.35
McFadden's pseudo-R^2	0.07	0.05	0.05
AIC/n	2.54	2.58	2.59
n (observations)	1480.00	1112.00	1320.00
k (parameters)	17.00	17.00	17.00

Table 31: Estimation results – MXL for urban, suburban, rural residence area, preference-space

	Urban		Suburban		Rural	
	Mean (s.e.)	Standard deviation (s.e.)	Mean (s.e.)	Standard deviation (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-1.4258*** (0.2723)	2.1291*** (0.1299)	-2.0900** (0.9256)	2.4176*** (0.4742)	-1.9334** (0.9274)	1.4238*** (0.5167)
PV	-1.0528*** (0.2829)	1.7702*** (0.1490)	-1.0064 (1.0979)	1.9276*** (0.6108)	-3.0086*** (0.8884)	2.2738*** (0.3182)
EV	-1.4637*** (0.3589)	3.1394*** (0.1624)	-2.2471** (1.1058)	2.5913*** (0.6172)	-4.2281*** (1.2204)	3.9225*** (0.6184)
PP	-1.1424*** (0.0714)	0.9495*** (0.0623)	-1.5178*** (0.2382)	1.4536*** (0.2869)	-1.7289*** (0.2297)	1.4775*** (0.2707)
PP*HV	0.0166 (0.0318)	0.1661*** (0.0385)	-0.0471 (0.1301)	0.2487** (0.1055)	-0.0500 (0.1243)	0.4638*** (0.1479)
PP*PV	0.0053 (0.0245)	0.0172 (0.0265)	-0.1960 (0.1020)	0.2031 (0.1424)	0.1092 (0.1067)	0.0936 (0.1105)
PP*EV	-0.1171*** (0.0257)	0.3265*** (0.0559)	-0.1324 (0.1314)	0.2569 (0.1313)	0.0480 (0.1334)	0.2075 (0.1428)
OC	-3.5925*** (0.3815)	0.0000 (0.0000)	-4.1852*** (1.2305)	0.9923 (1.4044)	-6.1621*** (1.0174)	0.0000 (1.7788)
OC*HV	-0.0152 (0.2631)	0.0000 (0.0000)	0.4862 (0.8137)	0.8800 (0.7030)	1.0902 (1.0201)	1.4138** (0.6458)
OC*PV	-0.0419 (0.3155)	1.6170*** (0.2054)	0.3464 (1.2227)	2.5648*** (0.8139)	1.5771** (0.8024)	0.3280 (0.9157)
OC*EV	-1.8505*** (0.5922)	2.2780*** (0.4572)	0.5755 (2.0615)	4.8778*** (1.6460)	0.8969 (2.2070)	5.6194*** (1.6425)
DR	0.1597*** (0.0145)	0.1055*** (0.0372)	0.2152*** (0.0490)	0.1952*** (0.0704)	0.1891*** (0.0379)	0.0000 (0.1298)
RT	-0.1197*** (0.0220)	0.2093*** (0.0336)	-0.1190 (0.0687)	0.2013** (0.0978)	-0.0680 (0.0561)	0.1918** (0.0831)
FT	0.1176 (0.0608)	0.8322*** (0.0810)	0.3196** (0.1600)	0.2806 (0.4496)	0.0685 (0.1538)	0.5546 (0.2981)
FP	0.2987*** (0.0575)	0.6762*** (0.0983)	0.1573 (0.1917)	0.8836*** (0.2838)	0.3754** (0.1581)	0.8624*** (0.2185)
INFR2	0.6156*** (0.0860)	0.0000 (0.0000)	0.4454 (0.2331)	0.5336 (0.5493)	0.7034*** (0.2533)	0.5288 (0.4225)
INFR3	0.9239*** (0.0881)	0.8741*** (0.1257)	1.1759*** (0.2728)	0.9653** (0.4184)	1.4611*** (0.2623)	0.9849*** (0.3015)
Model characteristics						
Log-likelihood (constants only)						
Log-likelihood	-6654.96		-1070.01		-1304.56	
McFadden's pseudo-R^2	0.26		0.28		0.27	
AIC/n	1.99		1.99		2.03	
n (observations)	6712.00		1112.00		1320.00	
k (parameters)	34.00		34.00		34.00	

Table 32: Estimation results – attributes specific to income level, preference-space

	MNL		MXL			
	coef.	st.err.	coef. (mean)	st.err. (mean)	coef. (std)	st.err. (std)
HV	-0.8453	*0.0711*	-1.5133	*0.2081*	2.2058	*0.2063*
HV*INCOME	0.2936	*0.0739*	0.3832	*0.2335*	0.8186	*0.3682*
HV*INCOME_NaN	0.1409	*0.1899*	0.2129	*0.6149*	1.1448	*0.9266*
PV	-0.6919	*0.0846*	-1.2106	*0.2049*	2.2379	*0.1915*
PV*INCOME	0.0857	*0.0952*	-0.1466	*0.2396*	0.8577	*0.3676*
PV*INCOME_NaN	-0.1223	*0.2294*	-0.7572	*0.6614*	1.4304	*0.8727*
EV	-0.6678	*0.1453*	-2.4335	*0.3488*	3.2283	*0.2541*
EV*INCOME	-0.5789	*0.1814*	-1.6554	*0.4734*	0.9953	*0.4544*
EV*INCOME_NaN	-0.2274	*0.3925*	-2.9578	*1.2090*	3.6411	*0.9626*
PP	-0.4889	*0.0409*	-1.3166	*0.1161*	1.1241	*0.1286*
PP*INCOME	0.0795	*0.0276*	-0.0136	*0.1038*	0.0688	*0.2466*
PP*INCOME_NaN	0.0746	*0.0965*	-0.4886	*0.3870*	1.4033	*0.4394*
OC	-1.3779	*0.1811*	-3.9368	*0.5009*	0.0000	*0.8590*
OC*INCOME	-0.8992	*0.2764*	-2.2802	*0.8070*	0.7487	*0.9190*
OC*INCOME_NaN	0.7085	*0.5088*	-1.5416	*1.9570*	1.8630	*1.9535*
DR	0.1272	*0.0139*	0.1969	*0.0230*	0.1203	*0.0443*
DR*INCOME	-0.0231	*0.0152*	-0.0451	*0.0335*	0.0334	*0.0880*
DR*INCOME_NaN	-0.0636	*0.0372*	-0.0520	*0.0830*	0.0067	*0.1433*
RT	-0.0477	*0.0170*	-0.1273	*0.0350*	0.1341	*0.0530*
RT*INCOME	0.0326	*0.0199*	0.0134	*0.0578*	0.3299	*0.0575*
RT*INCOME_NaN	0.0975	*0.0465*	0.1069	*0.1404*	0.0319	*0.2189*
FT	0.0993	*0.0484*	0.1072	*0.0961*	0.5076	*0.1552*
FT*INCOME	0.0483	*0.0527*	0.2074	*0.1357*	0.5444	*0.2070*
FT*INCOME_NaN	0.0971	*0.1317*	0.2009	*0.3181*	0.0341	*0.7766*
FP	0.1673	*0.0483*	0.2680	*0.0922*	0.4858	*0.1612*
FP*INCOME	0.0227	*0.0528*	0.0355	*0.1236*	0.0002	*0.3762*
FP*INCOME_NaN	0.0923	*0.1314*	0.0007	*0.3583*	1.3857	*0.3336*
INFR 2	0.3853	*0.0811*	0.7091	*0.1403*	0.5074	*0.2466*
INFR 2*INCOME	-0.1145	*0.0922*	0.1230	*0.1796*	0.0001	*0.5378*
INFR 2*INCOME_NaN	-0.3100	*0.2210*	-0.2087	*0.4487*	0.0139	*0.9512*
INFR 3	0.6785	*0.0779*	1.2553	*0.1262*	0.6633	*0.1790*
INFR 3*INCOME	-0.0814	*0.0884*	0.0172	*0.1657*	0.0611	*0.4834*
INFR 3*INCOME_NaN	-0.3376	*0.2117*	-0.4014	*0.4629*	0.6221	*0.7589*
Model characteristics						
LL0	-5273.54		-5273.54			
LL	-4991.18		-3842.68			
McFadden's R^2	0.05		0.27			
AIC/n	2.57		2.00			
n (observations)	3912		3912			
k (parameters)	33		66			

Table 33: Estimation results – attributes specific to families with a child, preference-space

	MNL		MXL			
	coef.	st.err.	coef. (mean)	st.err. (mean)	coef. (std)	st.err. (std)
HV	-0.8481	*0.0822*	-1.1716	*0.0959*	2.0539	*0.0866*
HV*CHILDd	0.1245	*0.1207*	-0.5882	*0.1525*	1.2821	*0.2561*
HV*CHILD_NaN	-0.5823	*0.3831*	-0.2699	*0.3793*	1.4243	*0.5318*
PV	-0.7401	*0.0992*	-0.9806	*0.0994*	2.1108	*0.0730*
PV*CHILDd	0.1317	*0.1464*	-0.2516	*0.1478*	0.4444	*0.2931*
PV*CHILD_NaN	-0.8328	*0.4801*	-0.2686	*0.4096*	1.5752	*0.4413*
EV	-0.5655	*0.1685*	-2.1504	*0.1983*	2.8281	*0.1380*
EV*CHILDd	-0.2060	*0.2541*	-0.1421	*0.3007*	1.8226	*0.3634*
EV*CHILD_NaN	0.0404	*0.7946*	0.4070	*0.6946*	0.8397	*0.3778*
PP	-0.4234	*0.0393*	-0.9884	*0.0499*	0.7890	*0.0409*
PP*CHILDd	-0.0343	*0.0590*	-0.2052	*0.0683*	0.1368	*0.0830*
PP*CHILD_NaN	0.0040	*0.2351*	-0.9024	*0.2601*	1.4380	*0.2200*
OC	-0.9644	*0.2028*	-3.2764	*0.2715*	0.7231	*0.3576*
OC*CHILDd	-0.3922	*0.3248*	-0.0619	*0.4295*	0.1286	*0.4082*
OC*CHILD_NaN	1.5108	*1.0488*	-0.1338	*1.1483*	0.0000	*0.0002*
DR	0.1196	*0.0163*	0.1556	*0.0115*	0.0000	*0.0000*
DR*CHILDd	-0.0139	*0.0240*	-0.0112	*0.0170*	0.0000	*0.0000*
DR*CHILD_NaN	0.0295	*0.0730*	-0.0158	*0.0609*	0.3138	*0.0618*
RT	-0.0431	*0.0201*	-0.1137	*0.0189*	0.2104	*0.0283*
RT*CHILDd	0.0204	*0.0299*	0.0109	*0.0262*	0.0696	*0.0552*
RT*CHILD_NaN	0.1206	*0.0936*	-0.1098	*0.0765*	0.0898	*0.1166*
FT	0.1309	*0.0569*	0.0654	*0.0481*	0.6840	*0.0757*
FT*CHILDd	-0.0143	*0.0840*	0.0715	*0.0735*	0.4164	*0.1719*
FT*CHILD_NaN	-0.2020	*0.2759*	0.0515	*0.2057*	0.0202	*0.3215*
FP	0.1685	*0.0566*	0.1785	*0.0466*	0.6408	*0.0586*
FP*CHILDd	0.0156	*0.0837*	0.0928	*0.0698*	0.0000	*0.0000*
FP*CHILD_NaN	0.3801	*0.2737*	0.1369	*0.1964*	0.0000	*0.0001*
INFR2	0.4274	*0.0946*	0.7098	*0.0705*	0.0000	*0.0002*
INFR 2*CHILDd	-0.2489	*0.1419*	-0.2286	*0.1073*	0.3784	*0.1833*
INFR 2*CHILD_NaN	-0.1467	*0.4377*	-0.1697	*0.3227*	1.0242	*0.3701*
INFR 3	0.6380	*0.0912*	0.9289	*0.0730*	0.8368	*0.0870*
INFR 3*CHILDd	-0.0627	*0.1357*	-0.1350	*0.1075*	0.1952	*0.5472*
INFR 3*CHILD_NaN	-0.0415	*0.4188*	0.1854	*0.3236*	0.8922	*0.4371*
Model characteristics						
LL0	-5273.54		-23095.00			
LL	-5022.84		-17466.67			
McFadden's R^2	0.05		0.24			
AIC/n	2.58		2.03			
n (observations)	3912		3912			
k (parameters)	33		66			

Table 34: Estimation results –attributes specific to engine size, preference-space

	MNL		MXL			
	coef.	st.err.	coef. (mean)	st.err. (mean)	coef. (std)	st.err. (std)
HV	-0.8858	*0.0974*	-1.3567	*0.2849*	2.2948	*0.2149*
HV*ENGINE	0.0840	*0.1471*	-0.3810	*0.4088*	0.9015	*0.2961*
HV*ENGINE_NaN	0.2892	*0.3427*	-0.7222	*1.0072*	1.1875	*0.7058*
PV	-0.5239	*0.1141*	-1.1085	*0.2762*	2.2057	*0.1695*
PV*ENGINE	-0.3013	*0.1816*	-0.4510	*0.4230*	0.5705	*0.3288*
PV*ENGINE_NaN	-0.8793	*0.4172*	-1.0497	*0.9960*	0.0001	*0.6229*
EV	-0.0568	*0.1948*	-1.7148	*0.4273*	3.0740	*0.2307*
EV*ENGINE	-1.4192	*0.3301*	-2.3568	*0.7292*	0.9636	*0.3465*
EV*ENGINE_NaN	-2.9676	*0.7349*	-5.1661	*1.7366*	2.4289	*0.6641*
PP	-0.5647	*0.0494*	-1.4750	*0.1616*	1.0660	*0.1172*
PP*ENGINE	0.2400	*0.0590*	0.3163	*0.2320*	0.1912	*0.1965*
PP*ENGINE_NaN	0.4569	*0.1547*	0.3355	*0.5696*	0.0000	*0.3704*
OC	-0.6117	*0.2278*	-2.9528	*0.6319*	0.0000	*0.8384*
OC*ENGINE	-0.8027	*0.3630*	-1.6375	*1.0760*	2.1754	*0.5598*
OC*ENGINE_NaN	-1.9507	*0.8169*	-3.8768	*2.6307*	2.2576	*1.3793*
DR	0.0930	*0.0189*	0.1451	*0.0294*	0.1075	*0.0376*
DR*ENGINE	0.0410	*0.0296*	0.0969	*0.0516*	0.0128	*0.0555*
DR*ENGINE_NaN	0.1046	*0.0684*	0.2448	*0.1180*	0.0299	*0.1129*
RT	-0.0625	*0.0230*	-0.1017	*0.0418*	0.0000	*0.0774*
RT*ENGINE	0.0732	*0.0393*	0.0305	*0.0831*	0.2673	*0.0506*
RT*ENGINE_NaN	0.1701	*0.0873*	0.0237	*0.2023*	0.0606	*0.1778*
FT	0.0693	*0.0655*	0.0292	*0.1124*	0.4866	*0.1796*
FT*ENGINE	-0.0038	*0.1060*	0.1586	*0.2043*	0.4691	*0.1756*
FT*ENGINE_NaN	0.1861	*0.2414*	0.5507	*0.4772*	0.0255	*0.6641*
FP	0.1413	*0.0652*	0.1807	*0.1340*	0.5096	*0.1634*
FP*ENGINE	0.1817	*0.1061*	0.3412	*0.2400*	0.0731	*0.2751*
FP*ENGINE_NaN	0.2683	*0.2410*	0.5040	*0.5644*	1.0640	*0.3453*
INFR2	0.2118	*0.1091*	0.5242	*0.2053*	0.3931	*0.2887*
INFR2*ENGINE	0.1673	*0.1808*	0.2704	*0.3475*	0.5510	*0.1930*
INFR2*ENGINE_NaN	0.5025	*0.4093*	0.7174	*0.8178*	0.1308	*0.7287*
INFR3	0.5464	*0.1046*	1.1362	*0.1741*	0.8055	*0.1695*
INFR3*ENGINE	0.0334	*0.1707*	-0.0064	*0.3196*	0.0698	*0.4102*
INFR3*ENGINE_NaN	0.2612	*0.3880*	0.0874	*0.7297*	0.7208	*0.5223*
LL0						
LL	-5273.54		-5273.54			
McFadden's R^2	-4983.84		-3856.18			
AIC/n	0.05		0.27			
n (observations)	2.56		2.01			
k (parameters)	3912		3912			
k	33		66			

Table 35: Estimation results –attributes specific to mileage, preference-space

	MNL		MXL			
	coef.	st.err.	coef. (mean)	st.err. (mean)	coef. (std)	st.err. (std)
HV	-0.7188	*0.0717*	-1.3115	*0.2147*	2.2797	*0.1961*
HV*MILEAGE	-0.0807	*0.0770*	-0.3302	*0.2301*	0.6582	*0.2902*
HV*MILEAGE_NaN	-0.2046	*0.2048*	-0.8830	*0.6051*	0.0000	*0.6995*
PV	-0.5655	*0.0839*	-1.2844	*0.2188*	2.3630	*0.1811*
PV*MILEAGE	-0.2008	*0.0971*	-0.4236	*0.2348*	0.3757	*0.3151*
PV*MILEAGE_NaN	-0.7486	*0.2472*	-0.7988	*0.6511*	0.7221	*0.7555*
EV	-0.7087	*0.1638*	-2.6933	*0.3570*	3.4534	*0.2722*
EV*MILEAGE	-0.6301	*0.1686*	-1.4479	*0.4428*	1.9273	*0.4195*
EV*MILEAGE_NaN	-1.6606	*0.4705*	-3.0983	*1.6216*	2.1279	*0.9787*
PP	-0.4458	*0.0377*	-1.5601	*0.1245*	1.2332	*0.1169*
PP*MILEAGE	-0.0105	*0.0351*	0.1752	*0.1298*	0.0000	*0.1680*
PP*MILEAGE_NaN	-0.0023	*0.1080*	0.4742	*0.3979*	0.4772	*0.3987*
OC	-1.6842	*0.2646*	-4.4860	*0.5502*	0.0026	*0.7406*
OC*MILEAGE	-1.0159	*0.2889*	-2.4393	*0.6639*	1.8468	*0.9284*
OC*MILEAGE_NaN	-2.6636	*0.8184*	-4.8091	*2.4366*	2.7531	*2.2630*
DR	0.1239	*0.0138*	0.2204	*0.0230*	0.0823	*0.0473*
DR*MILEAGE	-0.0132	*0.0153*	-0.0523	*0.0338*	0.0675	*0.0502*
DR*MILEAGE_NaN	-0.0473	*0.0395*	-0.1269	*0.0854*	0.0548	*0.1742*
RT	-0.0507	*0.0169*	-0.1053	*0.0361*	0.1570	*0.0483*
RT*MILEAGE	0.0312	*0.0196*	0.0429	*0.0494*	0.2379	*0.0514*
RT*MILEAGE_NaN	0.0832	*0.0488*	0.0514	*0.1514*	0.1003	*0.1359*
FT	0.1077	*0.0476*	0.1029	*0.0925*	0.4694	*0.1759*
FT*MILEAGE	-0.0401	*0.0549*	-0.0453	*0.1380*	0.5694	*0.1637*
FT*MILEAGE_NaN	0.0307	*0.1384*	-0.0440	*0.3740*	0.0451	*0.6565*
FP	0.1787	*0.0474*	0.3083	*0.0907*	0.4435	*0.1737*
FP*MILEAGE	0.0722	*0.0554*	0.2152	*0.1288*	0.3339	*0.1807*
FP*MILEAGE_NaN	-0.0012	*0.1383*	-0.0792	*0.3790*	1.0766	*0.3377*
INFR2	0.2809	*0.0792*	0.6482	*0.1403*	0.0042	*0.4974*
INFR2*MILEAGE	-0.0222	*0.0964*	-0.0015	*0.2190*	0.5454	*0.2921*
INFR2*MILEAGE_NaN	0.2438	*0.2344*	0.1812	*0.6033*	1.8056	*0.6089*
INFR3	0.5195	*0.0761*	1.0975	*0.1390*	0.7428	*0.1755*
INFR3*MILEAGE	0.2208	*0.0906*	0.4108	*0.2147*	0.6565	*0.2865*
INFR3*MILEAGE_NaN	0.6407	*0.2252*	1.1784	*0.5296*	0.0000	*0.8294*
Model characteristics						
LL0	-5273.54		-5273.54			
LL	-5003.16		-3841.31			
McFadden's R^2	0.05		0.27			
AIC/n	2.57		2.00			
n (observations)	3912		3912			
k (parameters)	33		66			

Deriving elasticities

Using the results as documented in Tables 45 and 46, we derived the elasticities. We follow same approach as the one in Deliverable 3.2 (Hanappi and Mayr 2014). We first predict choice probabilities in the base scenario, and then simulate 10-% increases in the price and cost parameter. As a result we obtain the predicted choice probabilities after the price or cost increase which can then be used to compute the corresponding percentage change on individual level. However, since (alternative-specific) parameter estimates differ from one alternative to the other, we obtain specific elasticities for each cost parameter that is increased, i.e. a 10% price increase has a different impact on the corresponding market share depending on which alternative fuel vehicle mode is affected.

Table 36 depicts results from an increase in purchase prices of each of the four types of passenger vehicles by 10% grouped by degree of urbanisation and educational level. Upper part of the table reports the elasticities assuming 40,000 PLN of the base purchasing price (average PP used in our experiments), whereas 30,000 PLN are assumed in the lower part. In both cases we assume operational and fuel costs equal to 75 PLN per 100 kilometer. Elasticity on probability to choose respective car technology with respect to its purchasing price is about -1.0. The largest elasticity is for EV, while chose on CVs is the least price sensitive. Respondents living in suburban area and low educated are less price sensitive to buy an EV than more educated people living in urban or rural area. Respondents living in rural area and medium skilled are most senstive on changes in purchase price of hybrid or plug-in hybrid vehicles.

Table 37 reports results for elasticities of vehicle choice with respect to operation and fuel price. Upper part dispalys results for OC equal to 35 PLN per 100 km that corresponds to price of conventional fuel, the lower part displays the results for OC equal to 75 PLN per 100 km that is average OC we applied in our experiments (PP=40,000 PLN assumed in both cases). On average, this direct price elasticity amounts about -0.4 and -0.8 in the case of fuel costs (≈35 PLN per 100 km) or total operational costs (≈75 PLN per 100 km), respectively.

Table 36: Purchase price elasticities of vehicle choice

PP=40,000 PLN	CV	HV	PV	EV
low skills	-1.16	-1.06	-1.04	-1.00
medium skills	-0.85	-1.19	-1.11	-1.32
high skills	-0.86	-1.12	-1.09	-1.39
urban	-0.92	-1.14	-1.16	-1.45
suburban	-0.74	-0.98	-0.94	-1.14
rural	-1.02	-1.29	-1.20	-1.43

PP=30,000 PLN	CV	HV	PV	EV
edu_low	-0.84	-0.81	-0.80	-0.77
edu_med	-0.65	-0.90	-0.85	-1.00
edu_high	-0.64	-0.85	-0.83	-1.06
urban	-0.69	-0.87	-0.88	-1.10
suburban	-0.55	-0.75	-0.72	-0.86
rural	-0.75	-0.99	-0.92	-1.09

Table 37: Operation and fuel cost elasticities of vehicle choice

OC=35 PLN per 100km	CV	HV	PV	EV
edu_low	-0.04	-0.10	-0.03	-0.15
edu_med	-0.18	-0.26	-0.35	-0.56
edu_high	-0.40	-0.58	-0.55	-0.95
urban	-0.26	-0.39	-0.35	-0.70
suburban	-0.23	-0.32	-0.32	-0.59
rural	-0.36	-0.49	-0.55	-0.81

OC=75 PLN per 100km	CV	HV	PV	EV
edu_low	-0.08	-0.21	-0.07	-0.33
edu_med	-0.34	-0.54	-0.75	-1.27
edu_high	-0.84	-1.18	-1.12	-2.04
urban	-0.52	-0.81	-0.73	-1.55
suburban	-0.47	-0.66	-0.67	-1.30
rural	-0.74	-1.00	-1.13	-1.75

9 Conclusion

I. Identification of **triggers and barriers of purchase of low carbon vehicles and car-sharing in Poland**.

- Most of people who intend to buy a vehicle within 10 years have already heard about electric or hybrid vehicles (87% or 83%), however, hybrid vehicles with plug-in are much less known (64%).
- Only 27% of consumers have ever considered buying an electricity driven vehicle, most of them hybrid and then hybrid with plug-in (33% and 29%).
- Under current conditions, there are only few people (5% CNG, 2% electric or hybrid) who plan to buy an alternative vehicle (we provided information about alternative fuel vehicles later in the questionnaire as part of described scenario).
- People who intend to buy a vehicle perceive as important barriers for their potential purchase of electric vehicle: narrower assortment than of conventional vehicles, lack of service places, and poor availability of public charging stations in Poland. Electric vehicles are generally perceived as less noisy. People tend to believe that if they buy an electric vehicle they will contribute to lowering of CO2 emissions and air pollution in cities and towns. However, these advantages of electric vehicles are not among the most important factors when purchasing a car, which are more likely low failure rate, safety, fuel consumption, maintenance and fuel costs, equipment, interior space and purchase price etc., but consumer segments have to be considered.
- About a quarter of our respondents have heard about car-sharing or car-pooling systems, and a higher share of them has used the former rather than the latter system. Lowering the cost of car-sharing, for instance, by providing a tax rebate on fuel or electricity, would motivate Polish travelers to use this system more, and the share of its users is slightly higher for a car fleet that would include EVs only.

II. **Estimation of willingness-to-pay of Polish consumers for hybrid (HV), plug-in hybrid (PHEV) and electric vehicles (EV) and for specific attributes of passenger vehicles**

- We asked respondents to imagine that a public program would be introduced and slow mode charging sockets with electricity use meters would be installed, thus they would be able to **charge an electric or plug-in hybrid vehicle in the place where they usually park** it, even if they don't own a garage. However, preferences of Polish consumers for hybrid and electric vehicles were still **significantly lower than for conventional vehicles**.
- **Driving range and recharging time** are important attributes of a passenger car which Polish consumers intend to buy. On average, Polish drivers are willing to pay about 2,500 zł for each additional 100 km of driving range. Drivers who intend to buy a second-hand car value the driving range less (1,668 zł per each 100 km) than consumers who intend to buy a new car (3,262 zł).
- **Recharging time and availability of charging stations** are currently **the most important barriers** to larger spread of electric and plug-in hybrid vehicles. On average, Polish drivers are willing to pay slightly less than 1,000 zł for each hour saved for recharging. Those who intend to buy a new car are again willing to pay more than second-hand car segment (1,300 zł vs. 500 zł).
- Preference for AFVs markedly rose, when **availability of fast-mode recharging** improved from low level (20% of fuel stations + at few public places) to medium level (60% of fuel stations + at half of public places) or even high level (90% of fuel stations + at almost all public places). Their willingness to pay for medium availability of fast mode recharging infrastructure is slightly more than 6,000 zł, and it is twice large for high availability (new care segment).

  - Providing other benefits, such as free parking and public transport, increases the probability to choose the AFVs. The second-hand car drivers stated implicit WTP value for free **public transport** for all family members of 1,700 zł and for **free parking in Poland** at 2,550 zł. The new car segment stated higher WTPs - 5,300 zł and 6,600 zł.
  - After controlling for all vehicle attributes, the most favoured AFV label is electric car, whereas hybrid car would be chosen the least often.
- Results of the mixed logit models indicate that consumer preferences for AFVs and their characteristics are highly diverse. An interaction model reveals that **higher levels of income** increase probability to purchase HV and PHEV and weaken the effect of operational cost attribute. Effect of income on other attributes seems to be not significant. Having at least one child in a family reduces importance of other benefits (public transport and parking).
- **Larger vehicle engine size** reduces probability to buy an EV and in general reduces WTP value for all vehicle attributes due to lowering coefficient on purchasing price (marginal utility of income). Larger engine size increases importance of driving range, recharging time and parking for free.
- **The longer mileage** that a consumer expects to drive, the higher WTP for HV and PHEV and the lower WTP for EVs. And the more kilometres a respondent intend to drive, the more important operational costs are. On the other hand, driving more leads to considering the purchase price less.
- Consumers who prefer a **larger car** would less likely buy a HV and are more sensitive to operational costs. Those who pay their attention to **fuel efficiency** of a car are also less likely to buy a HV, but value parking for free more. Those who would like to buy **a safer car** do not care as much about the purchase price as others. Consumers who intend to buy more **environmentally-friendly** vehicle are more careful about recharging time (positive coefficient), but also less sensitive to operational costs and purchase price. Those with faster and more reliable cars pay larger attention to driving range of their car and not so much to its purchasing price.

III. **Analysis of the demand of Polish households for low carbon vehicles**

- Using the estimation results and simulating the effect of purchase price and operational costs on the probability to choose specific vehicle, the price elasticities for various household segments were derived.
- We find that **low educated respondents** are most sensitive to **purchase price of CV**, while this elasticity has the lowest value among more educated respondents who are rather most responsive to price changes of EVs, followed by price changes of HVs.
- On average, the highest price elasticity is estimated for price changes of EVs, especially among households living in **urban and suburban area**.

Regarding the **operational costs**, **low educated** respondents are almost **insensitive to the cost changes**. Again the largest elasticity with respect to operational costs is estimated for EVs. Respondents **living in rural area** are then more sensitive on the cost changes than the respondents living in suburban and urban areas. These results also hold for changes in operational costs at lower levels that reflect rather fuel costs.

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Appendix 1. Additional Results

Table 38: Estimation results –pooled data, speeders and pilot data excluded

	pooled data		speeders excluded		pilot excluded only	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
PP (10000 zl)	-0.0326	0.0012	-0.0378	0.0013	-0.0342	0.0014
OC	-0.0079	0.0007	-0.0081	0.0007	-0.0078	0.0007
DR	0.0009	0.0001	0.0009	0.0001	0.0009	0.0001
RT	-0.0340	0.0068	-0.0370	0.0069	-0.0386	0.0074
INFR2	0.2790	0.0315	0.3029	0.0325	0.3015	0.0344
INFR3	0.4284	0.0303	0.4680	0.0312	0.4179	0.0334
FP	0.1484	0.0193	0.1540	0.0199	0.1743	0.0209
FT	0.0980	0.0195	0.0991	0.0201	0.0998	0.0210
HV	-0.8604	0.0277	-0.8882	0.0287	-0.8551	0.0303
PV	-0.6599	0.0330	-0.6795	0.0340	-0.6533	0.0361
EV	-0.4627	0.0559	-0.4588	0.0574	-0.4458	0.0613
LL0	-23656		-22296		-19657	
LL	-25186		-23911		-20927	
AIC/n	2.61		2.59		2.61	
n	18168		17248		15096	
k	11		11		11	

Table 39: Estimation results – basic model

	MNL model		MXL model			
	Coef.	s.e.	Coeff. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)
HV	-0.8882	0.0287	-1.4309	0.0760	2.1913	0.0759
PV	-0.6795	0.0340	-1.1314	0.0751	2.1189	0.0669
EV	-0.4588	0.0574	-2.1370	0.1433	3.0539	0.0968
PP	-0.3775	0.0132	-1.0781	0.0412	0.8438	0.0416
OC	-0.8091	0.0702	-3.3022	0.2003	0.0000	0.0000
DR	0.0928	0.0056	0.1487	0.0087	0.0888	0.0239
RT	-0.0370	0.0069	-0.1084	0.0138	0.2234	0.0234
FT	0.0991	0.0201	0.0960	0.0366	0.7607	0.0581
FP	0.1540	0.0199	0.2208	0.0347	0.6463	0.0589
INFR2	0.3029	0.0325	0.6157	0.0536	0.2663	0.2414
INFR3	0.4680	0.0312	0.8819	0.0534	0.7823	0.0847
Log-likelihood (constants only)	-23095		-23095			
Log-likelihood	-22296		-17498			
McFadden's R^2	0.0346		0.2423			
AIC/n	2.5866		2.0315			
n (observations)	17248		17248			
k (parameters)	11		22			

Table 40: Estimation results – basic model in WTP-space

	MNL model		MXL model			
	Coef.	s.e.	Coeff. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)
HV	-2.353	0.0994	-1.712	0.0886	2.4697	0.0779
PV	-1.800	0.1013	-1.273	0.0823	2.3657	0.0767
EV	-1.215	0.1547	-2.627	0.1454	3.7338	0.1072
OC	-2.143	0.1986	-3.814	0.2047	0.7364	0.1674
DR	0.246	0.0159	0.152	0.0088	0.0000	0.0191
RT	-0.098	0.0181	-0.094	0.0135	0.1492	0.0153
FT	0.262	0.0528	0.139	0.0374	0.5362	0.0551
FP	0.408	0.0528	0.230	0.0381	0.5980	0.0533
INFR2	0.802	0.0876	0.556	0.0496	0.0000	0.0441
INFR3	1.240	0.0861	0.858	0.0543	0.7721	0.0709
PP	0.378	0.0104	-0.110	0.0329	0.9116	0.0373
Log-likelihood (constants only)	-23095		-23095			
Log-likelihood	-22296		-17561			
McFadden's R^2	0.035		0.240			
AIC/n	2.587		2.039			
n (observations)	17248		17248			
k (parameters)	11		22			

Table 41: Estimation results – price and costs alternative specific, preference-space

	MNL model		MXL model			
	Coef.	s.e.	Coeff. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)
HV	-0.9833	0.0726	-1.6897	0.1737	2.1336	0.0798
PV	-0.7376	0.0674	-1.4326	0.1613	2.0800	0.0799
EV	-0.1583	0.0753	-1.8361	0.2352	2.7827	0.1100
PP	-0.3971	0.0140	-1.1388	0.0418	0.8423	0.0388
PP*HV	0.0338	0.0069	0.0191	0.0214	0.1228	0.0193
PP*PV	0.0315	0.0061	0.0466	0.0138	0.0000	0.0000
PP*EV	-0.0098	0.0064	-0.0231	0.0214	0.3359	0.0309
OC	-1.2808	0.1200	-3.4736	0.2281	0.0000	0.0000
OC*HV	0.0187	0.0690	0.2227	0.1535	0.0000	0.0000
OC*PV	-0.0272	0.0616	0.1654	0.1561	0.6089	0.1793
OC*EV	-1.1224	0.1374	-0.8805	0.3695	1.3986	0.7124
DR	0.0938	0.0056	0.1503	0.0087	0.0842	0.0237
RT	-0.0443	0.0070	-0.1077	0.0133	0.2015	0.0209
FT	0.0973	0.0200	0.1098	0.0357	0.7149	0.0538
FP	0.1452	0.0199	0.2104	0.0345	0.6226	0.0593
INFR2	0.3095	0.0326	0.6170	0.0515	0.0000	0.0000
INFR3	0.4815	0.0313	0.8829	0.0533	0.8020	0.0781
Log-likelihood (constants only)						
Log-likelihood	-23095		-23095			
McFadden's R^2	-22233		-17483.3			
AIC/n	0.037		0.243			
n (observations)	2.580		2.031			
k (parameters)	17248		17248			

Table 42: Estimation results – new car segment, WTP-space

	MNL model		MXL model			
	Coef.	s.e.	Coeff. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)
HV	-2.8615	0.2870	-1.9750	0.2161	3.2988	0.1879
PV	-1.7502	0.2840	-0.9643	0.1697	3.1998	0.1539
EV	-1.9451	0.4751	-2.9251	0.3358	5.5133	0.3568
OC	-3.3735	0.6349	-4.8408	0.4317	0.0000	0.0002
DR	0.3262	0.0467	0.1418	0.0237	0.0000	0.0000
RT	-0.1328	0.0556	-0.1080	0.0300	0.1171	0.0233
FT	0.5311	0.1595	0.1705	0.0868	0.8926	0.1189
FP	0.6593	0.1597	0.3043	0.0869	0.9957	0.1530
INFR2	0.6891	0.2578	0.6666	0.1297	0.0000	0.0000
INFR3	1.1839	0.2497	0.7507	0.1559	1.4551	0.1185
PP	0.2724	0.0168	-0.2189	0.0801	1.2391	0.1075
Log-likelihood (constants only)	-5022		-5022			
Log-likelihood	-4807		-3719			
McFadden's R^2	0.0428		0.2593			
AIC/n	2.5903		2.0116			
n (observations)	3720		3720			
k (parameters)	11		22			

Table 43: Estimation results – used car segment, WTP-space

	MNL model		MXL model			
	Coef.	s.e.	Coeff. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)
HV	-1.6901	0.1147	-1.3469	0.1043	1.8462	0.1144
PV	-1.4125	0.1078	-1.0807	0.1039	1.9278	0.1112
EV	-0.7406	0.1381	-1.7651	0.1775	2.4843	0.1409
PP	-1.1478	0.1625	-2.4021	0.2423	0.4325	0.1525
OC	0.1668	0.0153	0.1145	0.0102	0.0000	0.0000
DR	-0.0522	0.0160	-0.0524	0.0133	0.1373	0.0324
RT	0.1716	0.0478	0.1010	0.0374	0.3826	0.0780
FT	0.2554	0.0480	0.1887	0.0349	0.1331	0.1566
FP	0.6510	0.0785	0.4728	0.0577	0.0000	
INFR2	0.8418	0.0804	0.6105	0.0614	0.3527	0.0613
INFR3	0.5850	0.0306	0.1814	0.0541	0.8317	0.0572
Log-likelihood (constants only)	-12553		-12553			
Log-likelihood	-12167		-9630			
McFadden's R^2	0.0307		0.2329			
AIC/n	2.5736		2.0397			
n (observations)	9464		9464			
k (parameters)	11		22			

Table 44: Estimation results – segment of undecided, WTP-space

	MNL model		MXL model			
	Coef.	s.e.	Coeff. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)
HV	-1.6694	0.1672	-1.2054	0.1581	2.1252	0.1887
PV	-1.2388	0.1721	-0.8898	0.1527	2.1234	0.1753
EV	-0.9298	0.2766	-2.9727	0.3241	4.0866	0.3186
PP	-2.2878	0.3788	-4.4224	0.4829	0.2838	0.3467
OC	0.2010	0.0279	0.1344	0.0179	0.0000	0.0000
DR	-0.1251	0.0325	-0.1250	0.0256	0.0000	0.0000
RT	0.1129	0.0924	0.0622	0.0776	0.9800	0.1142
FT	0.3573	0.0932	0.2420	0.0667	0.5523	0.0838
FP	0.6703	0.1553	0.6137	0.1154	0.0000	0.0000
INFR2	1.3466	0.1569	1.2235	0.1388	1.1113	0.1584
INFR3	0.4397	0.0260	0.0262	0.0743	0.8498	0.0927
Log-likelihood (constants only)	-5488		-5488			
Log-likelihood	-5237		-4093			
McFadden's R^2	0.0458		0.2543			
AIC/n	2.5826		2.0249			
n (observations)	4064		4064			
k (parameters)	11		22			

Table 45: Estimation results – MNL for low, medium and high level of education, preference-space

	Low education		Medium education		High education	
	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.
HV	**-1.2315**	0.1926	**-0.5671**	0.1386	**-1.1294**	0.0963
PV	**-1.1890**	0.1762	-0.0940	0.1360	**-0.9230**	0.0880
EV	-0.1938	0.1931	**0.5080**	0.1476	**-0.5004**	0.0993
PP	**-0.4691**	0.0449	**-0.3674**	0.0286	**-0.4064**	0.0174
PP*HV	**0.1378**	0.0252	-0.0190	0.0152	**0.0406**	0.0084
PP*PV	**0.1343**	0.0231	-0.0092	0.0131	**0.0348**	0.0075
PP*EV	**0.1089**	0.0220	**-0.0532**	0.0134	-0.0047	0.0080
OC	-0.1771	0.3063	**-0.7732**	0.2349	**-1.8105**	0.1580
OC*HV	-0.1554	0.1668	-0.1390	0.1291	0.1494	0.0946
OC*PV	0.0597	0.1417	**-0.5529**	0.1281	**0.1778**	0.0823
OC*EV	-0.4405	0.3439	**-1.3746**	0.2690	**-1.1331**	0.1817
DR	**0.0783**	0.0154	**0.1050**	0.0111	**0.0926**	0.0072
RT	**-0.0428**	0.0185	**-0.0410**	0.0136	**-0.0458**	0.0091
FT	**0.1123**	0.0533	0.0494	0.0392	**0.1158**	0.0260
FP	**0.1339**	0.0528	**0.1304**	0.0389	**0.1557**	0.0258
INFR2	**0.3533**	0.0852	**0.3202**	0.0633	**0.2947**	0.0427
INFR3	**0.4565**	0.0828	**0.4036**	0.0614	**0.5205**	0.0407
Model characteristics						
Log-likelihood (constants only)	-3220.27		-5975.91		-13880.55	
Log-likelihood	-3119.14		-5749.85		-13286.07	
McFadden's pseudo-R^2	0.031		0.038		0.043	
AIC/n	2.588		2.598		2.562	
n (observations)	2424		4440		10384	
k (parameters)	17		17		17	

Note: Significant coefficients at least 10% level are bolded.

Table 46: Estimation results – MNL for urban, suburban, rural residence area, preference-space

	Urban		Suburban		Rural	
	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.
HV	**-0.8150**	0.1137	**-0.8566**	0.1261	**-1.3805**	0.1458
PV	**-0.5878**	0.1049	**-0.6792**	0.1184	**-0.9804**	0.1363
EV	-0.0325	0.1205	-0.1074	0.1332	**-0.4490**	0.1437
PP	**-0.4136**	0.0233	**-0.3313**	0.0220	**-0.4769**	0.0286
PP*HV	**0.0397**	0.0115	0.0135	0.0107	**0.0599**	0.0152
PP*PV	0.0164	0.0105	**0.0177**	0.0094	**0.0754**	0.0130
PP*EV	**-0.0278**	0.0113	**-0.0189**	0.0099	**0.0339**	0.0131
OC	**-1.2508**	0.1938	**-1.1244**	0.2149	**-1.5400**	0.2192
OC*HV	-0.1453	0.1086	-0.0058	0.1173	**0.2876**	0.1406
OC*PV	-0.0569	0.0938	-0.0447	0.1059	-0.0095	0.1318
OC*EV	**-1.2738**	0.2195	**-1.0266**	0.2447	**-0.9429**	0.2573
DR	**0.1000**	0.0089	**0.0963**	0.0101	**0.0829**	0.0103
RT	**-0.0437**	0.0112	**-0.0401**	0.0126	**-0.0492**	0.0127
FT	**0.1043**	0.0320	**0.1283**	0.0358	0.0541	0.0371
FP	**0.1684**	0.0317	**0.1146**	0.0356	**0.1474**	0.0369
INFR2	**0.3124**	0.0523	**0.3221**	0.0582	**0.2970**	0.0601
INFR3	**0.4964**	0.0501	**0.4664**	0.0562	**0.4793**	0.0577
Model characteristics						
Log-likelihood (constants only)	-9033.33		-7220.48		-6825.27	
Log-likelihood	-8657.71		-6969.31		-6563.62	
McFadden's pseudo-R^2	0.042		0.035		0.038	
AIC/n	2.585		2.599		2.551	
n (observations)	6712		5376		5160	
k (parameters)	17		17		17	

Note: Significant coefficients at least 10% level are bolded.

Table 47: Estimation results – MXL for low, medium and high level of education, preference-space

	Low education				Medium education				High education			
	Coef. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)	Coef. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)	Coef. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)
HV	-2.9886	0.4496	1.9138	0.2028	-0.8573	0.3806	1.8866	0.1944	-1.7237	0.2249	2.0764	0.0987
PV	-2.2206	0.4624	2.4608	0.2134	-0.2466	0.3608	1.9528	0.1891	-1.6089	0.2107	2.1139	0.0900
EV	-1.5620	0.5365	2.6216	0.2611	-0.5625	0.4401	2.9045	0.1900	-2.5013	0.2867	3.0995	0.1404
PP	-1.5346	0.1529	1.1894	0.1412	-0.9362	0.0755	0.6828	0.0859	-1.1689	0.0528	0.8817	0.0497
PP*HV	0.3615	0.0676	0.3551	0.0600	-0.0786	0.0438	0.2277	0.0478	0.0380	0.0198	0.0455	0.0121
PP*PV	0.1975	0.0498	0.0345	0.0438	-0.0157	0.0351	0.0000	0.0000	0.0136	0.0163	0.0000	0.0000
PP*EV	0.2197	0.0790	0.3852	0.0517	-0.0775	0.0489	0.1846	0.0425	0.0293	0.0208	0.1198	0.0161
OC	-1.3065	0.5643	0.1824	0.3772	-2.1838	0.4429	0.0000	0.0000	-4.5250	0.3069	0.0000	0.0000
OC*HV	0.3966	0.3523	0.2579	0.2779	-0.4156	0.3770	1.2549	0.2848	0.2662	0.2149	0.0000	0.0000
OC*PV	0.2734	0.3804	0.5707	0.1907	-0.9286	0.3673	1.2673	0.2884	0.5734	0.2042	0.2747	0.2809
OC*EV	-0.3294	0.7442	2.0115	0.5206	-1.1990	0.6485	0.3532	0.4238	-1.1205	0.4467	0.8472	0.5953
DR	0.1105	0.0259	0.1740	0.0373	0.1616	0.0173	0.0987	0.0370	0.1538	0.0110	0.0480	0.0391
RT	-0.0822	0.0365	0.2236	0.0516	-0.1202	0.0267	0.2136	0.0480	-0.1165	0.0180	0.2162	0.0291
FT	0.1231	0.0906	0.3859	0.2579	0.0401	0.0674	0.6090	0.1071	0.1021	0.0484	0.8368	0.0683
FP	0.1221	0.0968	0.7354	0.1343	0.1971	0.0660	0.5516	0.1067	0.2535	0.0456	0.6593	0.0749
INFR2	0.7107	0.1441	0.4421	0.2683	0.6250	0.1023	0.2907	0.2960	0.6100	0.0682	0.0000	0.0000
INFR3	0.8347	0.1566	1.1653	0.1956	0.7140	0.1018	0.7280	0.1563	0.9881	0.0704	0.8418	0.1045
LL0	-3220.3				-5975.9				-13880.6			
Log-likelihood	-2403.8				-4521.2				-10465.4			
McFadden's R^2	0.254				0.243				0.246			
AIC/n	2.012				2.052				2.022			
n (observations)	2424				4440				10384			
k (parameters)	34				34				34			

Table 48: Estimation results – MXL for urban, suburban, and rural area of residence, preference-space

	Urban				Suburban				Rural			
	Coef. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)	Coef. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)	Coef. (Mean)	s.e. (Mean)	Coeff. (STD)	s.e. (STD)
HV	-1.4258	0.2723	2.1291	0.1299	-1.4709	0.2839	2.1159	0.1362	-2.0125	0.3584	2.0075	0.1540
PV	-1.0528	0.2829	1.7702	0.1490	-1.3373	0.2858	2.2173	0.1209	-1.7095	0.3105	2.0239	0.1150
EV	-1.4637	0.3589	3.1394	0.1624	-1.4252	0.3658	2.3226	0.2290	-2.6122	0.4091	2.7476	0.1801
PP	-1.1424	0.0714	0.9495	0.0623	-1.0358	0.0701	0.7938	0.0611	-1.2688	0.0816	0.9375	0.0819
PP*HV	0.0166	0.0318	0.1661	0.0385	0.0263	0.0235	0.0642	0.0209	0.0458	0.0308	0.1177	0.0288
PP*PV	0.0053	0.0245	0.0172	0.0265	0.0115	0.0212	0.0000	0.0000	0.0779	0.0293	0.0000	0.0000
PP*EV	-0.1171	0.0257	0.3265	0.0559	-0.0476	0.0369	0.3275	0.0731	0.1398	0.0341	0.1976	0.0585
OC	-3.5925	0.3815	0.0000	0.0000	-3.0082	0.3883	0.0000	0.0000	-3.9978	0.4121	0.0000	0.0000
OC*HV	-0.0152	0.2631	0.0000	0.0000	0.0442	0.2571	0.0000	0.0000	0.2665	0.3764	1.1434	0.2305
OC*PV	-0.0419	0.3155	1.6170	0.2054	0.0488	0.2612	0.0000	0.0000	0.3401	0.2961	0.0000	0.0000
OC*EV	-1.8505	0.5922	2.2780	0.4572	-1.1155	0.5499	2.0989	0.4863	0.1381	0.6203	0.0000	0.0000
DR	0.1597	0.0145	0.1055	0.0372	0.1482	0.0155	0.0944	0.0309	0.1415	0.0161	0.1061	0.0323
RT	-0.1197	0.0220	0.2093	0.0336	-0.1007	0.0241	0.1867	0.0452	-0.1214	0.0252	0.2719	0.0354
FT	0.1176	0.0608	0.8322	0.0810	0.1710	0.0623	0.6655	0.0983	-0.0197	0.0651	0.6485	0.0959
FP	0.2987	0.0575	0.6762	0.0983	0.1362	0.0615	0.6222	0.1001	0.2036	0.0625	0.6003	0.1069
INFR2	0.6156	0.0860	0.0000	0.0000	0.6785	0.0915	0.0000	0.0000	0.5766	0.0944	0.0000	0.0000
INFR3	0.9239	0.0881	0.8741	0.1257	0.8974	0.0949	0.8053	0.1476	0.8289	0.0960	0.6918	0.1628
LL0)	-9033.3				-7220.5				-6825.3			
Log-likelihood	-6655.0				-5534.4				-5235.0			
McFadden's R^2	0.263				0.234				0.233			
AIC/n	1.993				2.072				2.042			
n (observations)	6712				5376				5160			
k (parameters)	34				34				34			